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THE Society also is maintaining expeditions in the unknown area adjacent to the San Juan River in southeastern Utah, and in Yunnan, Kweichow, and Kansu, China—all regions virgin to scientific study.

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A VISIT TO CARLSBAD CAVERN

Recent Explorations of a Limestone Cave in the Guadalupe Mountains of New Mexico Reveal a Natural Wonder of the First Magnitude

BY WILLIS T. LEE

OCCASIONALLY a matter-of-fact statement of a geographic discovery sounds incredible. Such was the case with Jim Bridger's first accounts of the Yellowstone's geysers. The giant Redwoods of California would seem like a fairy-tale setting were a returning traveler to tell of their dimensions for the first time. Only recently a brand-new type of phenomenon, the Valley of Ten Thousand Smokes, Alaska, taxed comprehension until National Geographic photographs authenticated its prankish natural wonders.

Now comes the announcement of a remarkable cavern among the eastern foothills of the Guadalupe Mountains, in southeastern New Mexico—the Carlsbad Cavern, so named for the little town about thirty miles to the northwest.

The less scenic part has been known locally for many years as a bat cave and a source of guano. Recently explorers traversed several miles of its halls and chambers, and some parts of it were found to have such startling magnificence that, on October 25, 1923, by proclamation of President Coolidge, it was set aside as the Carlsbad National Monument.

THE JOURNEY TO THE CAVERN

On the 30-mile ride from Carlsbad to the cave, interest never flags. There is a varied display of prickly pears and melon cactus, and the scraggly leafless stalks of ocotillo. Spanish daggers, Spanish bayonets, and sotol plants (see illustration, page 28) are numerous. Century plants of several varieties are abundant, some forming beautiful rosettes which adorn the hillsides (see illustration, page 27), and others, known as lechuguilla, form mats of closely set spikes covering the surface.

The cavern is reached over a road sadly in need of improvement. Like many of the roads in the sparsely settled Southwest, this one is kept passable by each vehicle following the tracks of the one that has gone before, until the ruts become too deep, when a new route is sought out among the rocks, through the thorny mesquite bushes and over the mats of prickly pear.

Two hours of jolting into the ruts and out of them brings us to the foot of a steep, rocky slope from which every vestige of soil has been washed away, leaving a barren pavement of limestone. Here the laboring machines come to a halt, while their overheated engines cool, and the much-shaken passengers stretch their cramped limbs and test the strength of the spines that cover a large melon cactus at the side of the road where we alight.

NATURAL OPENING TO CARLSBAD CAVERN FORMED BY THE COLLAPSE OF THE ROOF

The rocks which once filled this space now lie on the floor of the cave, 170 feet below the surface. The scale is shown by the man standing beyond the opening.

Photographs by Willis T. Lee

A SINK-HOLE WHERE BEDS OF ROCK-SALT AND GYPSUM UNDERLIE THE SURFACE

This hole, 75 feet across and 60 feet deep, was formed in August, 1918, when a cavern collapsed. A part of the material from this hole now rests in a conical mound on the floor of the cavern; other parts have been distributed through subterranean passageways to find lodgment—who knows where?

Up this rocky slope we must make our laborious way to a bench on the mountain side about 1,000 feet above the valley. Some of the party remain in the jolting machines; others prefer to walk.

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DOMES RISING FROM A WET, SLIPPERY MOUND OF FLOWSTONE

The imaginative explorer faces a scene like this with awe. The eternal darkness, the Titanic proportions, the unbroken silence never interrupted by roll of thunder or more mundane sounds of the outside world, and the equable temperature that defies the seasons' changes—these are a few of the conditions which made caves refuges for men of prehistoric times and caused later races to people these "unearthly" places with gods and fairies.

THE CAVERN IS THE HOME OF COUNTLESS BATS

At the entrance to the cave an aspect presents itself for which we are quite unprepared. There are several dwellings, an engine-house, two hoisting shafts, and other evidences of activity. It seems that from prehistoric time the cave has been the home of countless numbers of bats. For several years past quantities of guano have been shipped from it. Although work was not in progress at the time of our visit, the hoisting machine was in working order, and by means of it the descent was safely made.

The natural opening to the cave is not now used and much work must be done before access through it is safe. It consists of a large hole, 100 feet or more across, from which the rocks have fallen into the cavern below, a distance of about 170 feet. This opening widens downward, somewhat like an inverted funnel.

This natural opening is used by the bats. At dusk each evening they begin to leave the cave for their night of foraging. For about three hours the winged stream resembles smoke pouring from a smokestack. Repellent as these little mammals are on close acquaintance, it is fascinating to watch the countless thousands of them leaving home, and to speculate on their destination and the nocturnal adventures awaiting them.

It is equally fascinating in the early morning to watch these same countless thousands returning home; to see each little creature fold its wings in mid-air and dart downward into the cave with incredible speed. Within, each individual seeks its own chosen nook or crack in which it may hook a tiny claw and hang

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ORNAMENTAL MONUMENTS AND ONYX WALLS, NEAR THE EASTERN END OF THE BIG ROOM (SEE TEXT, PAGE 27)

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FLOWSTONE STALAGMITE SHRINE SURROUNDED WITH PENDANTS OF ONYX

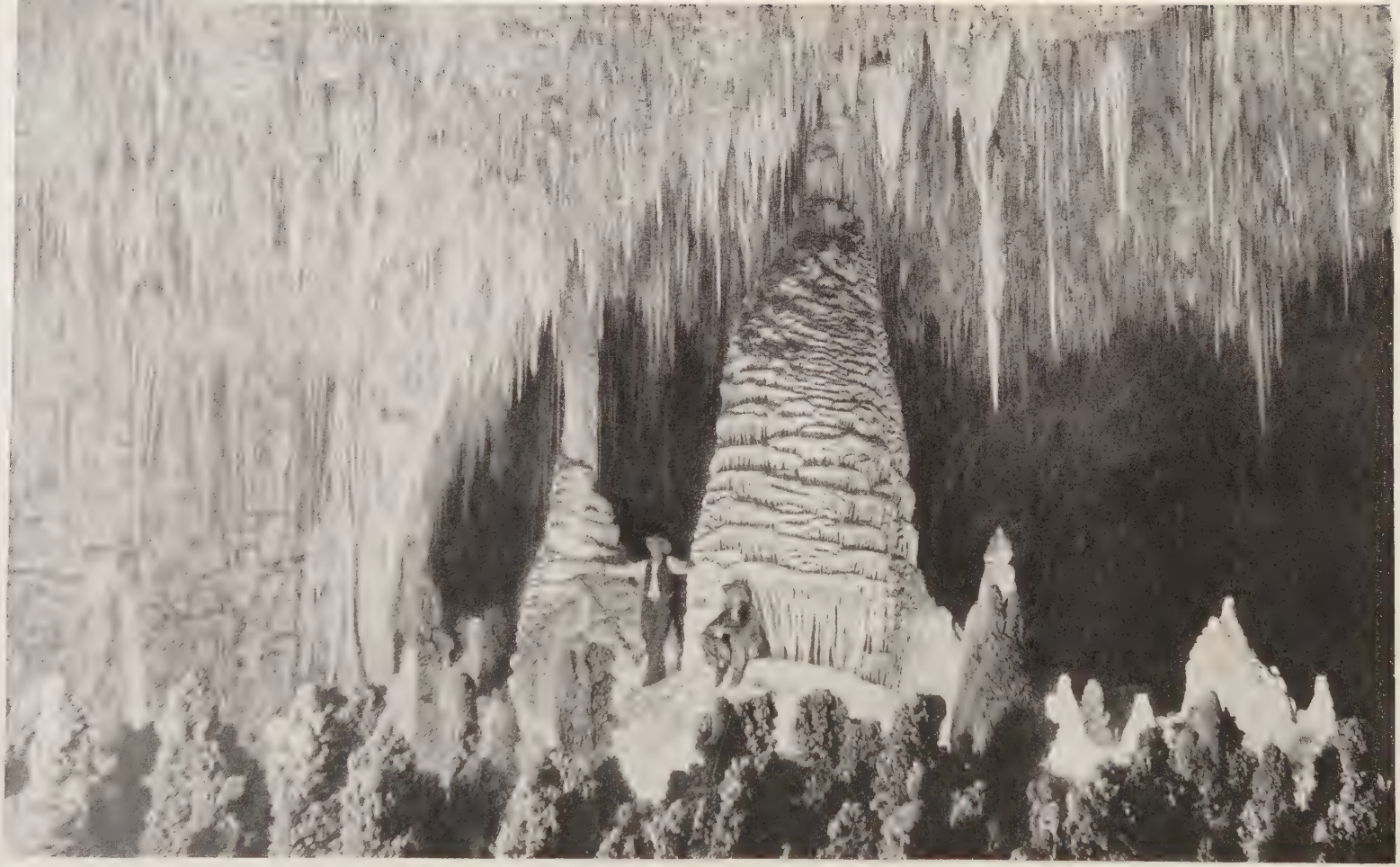
The Pillar of the Constitution, in the Wyandotte Cave, grows .01 to .03 of a centimeter a year. With these figures as a basis, the age of the Pillar has been variously estimated as being from 30,500 to 91,000 years. Other estimates of ages of stalagmites are from 560,000 to 600,000 years. As yet, Carlsbad Cavern has not been studied thoroughly enough for any accurate estimates of its age to be made, but since the stalagmites are much larger it is reasonable to believe that their age is much greater.

at ease until darkness again calls it forth.

But the guide has started his engine and the elevator is ready for operation. This elevator consists of a steel bucket at the end of a wire rope which passes over a pulley at the top of a derrick and is lowered through an artificial opening, or shaft, constructed for hoisting guano from the cave. The bucket holds two people if they are not too large, and if they stand very close together and hold very tightly to the wire rope.

The signal is given, the trapdoor at the top of the shaft opens, and we find ourselves dangling at the end of a line which seems like a mere thread over a black hole 170 feet deep.

Slowly we descend into the Stygian darkness, with only that threadlike rope between the world we know and love and that black, unknown inferno. The guide who operates the engine tries to be comfortingly reassuring. "The engine does not fail very often! But if it does, I can apply the friction brake before you *drop*



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HATIN'S DOME AND THE TEMPLE OF SUN

According to Navajo mythology, Hatin and Estsan made the sky and undertook to decorate it with bits of pearl and abalone shell which the messenger Wind carried aloft for them. The constellations had been completed when Coyote, the Son of Darkness, interfered and scattered the star material over the sky in disorderly manner. Beneath the dome is the shrine of the sun god before which range the numerous coraline stalagmites (see also pages 8 and 9).

© Ray V. Davis

THE GUIDE RESTING AGAINST A GIANT FLOWSTONE BEEHIVE

The floor of Shinav's Wigwam was built up during the ages by blocks fallen from the roof which have been cemented together with lime carbonate. The rooms are built one above the other for no-one-knows how many stories.

Photograph by Willis T. Lee

A PHANTOM BEAST IN THE SHADOWS OF CARLSBAD CAVERN

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TWO TYPES OF STALAGMITES

The massive flowstone stalagmites are smooth, while the smaller ones have a rough, coralline surface. The latter suggest a group of fur-clad aborigines worshiping at a shrine (see also page 6).

Photograph by Willis T. Lee

WHERE TINY DROPS OF WATER CARICATURE MAN

The corallike formations capped by smooth dripstones resemble bareheaded men in ragged clothing. A small figure on the floor to the left is shaped like a soldier's helmet. Some of these stalagmites are "drinking fountains," with splashcups at the top, which catch water dripping from above. Others are "frozen" fountains, in which the splashcup is filled with clear onyx, resembling ice (see text, page 30).

very far! In any case, there is soft material at the bottom of the shaft!"

It occurs to me, as we descend with starts and jerks, to wonder whether certain vivid descriptions in *Divina Commedia* were written after Dante had been lowered into a bat cave in a guano bucket.

IN VAST, DARK UNDERGROUND SPACES

On reaching the bottom we devote some time to getting our "cave eyes" and to preparing the torches which are to furnish light on our subterranean journey.

Gradually, as we become accustomed to the gloom, the enormity of the underground cavity which we have invaded is borne in upon us. The opening of the shaft above us is a mere speck of light. Weird, shadowy forms seem to approach out of the darkness, as our eyes gradually adjust themselves to the dim light. Finally the rugged sides of the cavern take form and we find ourselves in a passageway of unusual width, with arched roof so far above us that our torches only dimly illumine it.

The bats are found chiefly in the part of the cave east of the shaft. The scenic portions, toward which we now make our way, lie in the opposite direction.

For some distance the route is not difficult, but the pathway is rough, for the lower part of the cave is filled with angular blocks of rock fallen from the walls and ceiling. The thickness of this débris is not known, but in some places, where the blocks are large and the spaces between them open, men are said to have made their way downward 200 or 300 feet below the present floor.

Perhaps a statement in the interest of caution may be in place at this point. Very little accurate information relative to this cave is available. Few measurements have been made, and it is a well-recognized fact that, in dimly lighted caverns, imagination runs ahead of the tape-line. The guide is the only source of such

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YEITSO'S PILLAR, AN ONYX COLUMN NEAR THE ENTRANCE TO THE CAVERN

The water from the ceiling deposits its load of dissolved lime carbonate on its way downward, building tiny overflow fountains on the sides of the stalagmites, and finds its way at last into the large fountain shown in the foreground at the right, where the residuum of carbonate forms the embossed rim of the basin.

meager information as may be obtained. Far be it from me to cast aspersion on an estimable guide whose business it is to entertain his guests. Like other guides before him, he has discovered that tourists appreciate hair-raising yarns more than hair-splitting distinctions. According to his own statement, our guide does not allow dull fact to interfere with a good story.

Possibly there will in time appear here a sequel to the volume entitled "Truthful Lies," which will embody the strange characteristics of the Southwest, as that unique volume does those of Yellowstone Park. When such a volume is published I want to secure the first copy. However, in the present story I am using only such statements as seem reasonably justified by my own observation.

A CORRIDOR AS LONG AS THE INAUGURAL PARADE ROUTE

About half a mile from the foot of the shaft, we enter the part of the cave reserved as a national monument and soon pass beneath the natural opening. This opening, far above us, which seems so awesome at the surface, appears from the floor of the spacious cavern like a small

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GIANT COLUMNS OF A STYGIAN TEMPLE

The massive pillars rise from a broad base of dark, smooth flowstone of unknown dimensions. Only the lower portions show in the picture, and their great height may be judged by comparison with the human figures.

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DOH'S KIVA IN THE HALF-MILE-LONG BIG ROOM

According to Apache mythology, Doh, the fly, built a kiva for the sun, and in it were formed three deities. To be noted are the slender drinking fountain in the foreground, the large and smooth stalagmites of flowstone, the frostwork decoration of the walls, and numerous pendants of dripstone.

© Ray V. Davis

THE AZTEC'S SHRINE

For untold ages these monuments of onyx have stood in total darkness. Once, and only once, has their glory been made visible. Like some character in history, made prominent for a moment by some flash of circumstance, these forms stood forth proudly for an instant in the magnesium light which fixed the image on the photographic plate, and then returned to obscurity.

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SHINAV'S ROBE IN SHINAV'S WIGWAM

This is one of the curtainlike walls of the large room called Shinav's Wigwam, which has been formed by stalactites growing laterally until they coalesced into a great sheet or wall.

Photograph by Willis T. Lee

A NAVAJO BLANKET WALL IN SHINAV'S WIGWAM

To the right a parting of the drapery invites the visitor to an anteroom. To the left is a passageway to an adjoining chamber.

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A GROUP OF SLENDER, GRACEFUL STALAGMITES RESEMBLING TOTEM POLES IN THE BIG ROOM

Nature has here paid appropriate tribute to the Indian tribes which once ranged over the surface land of Carlsbad Cavern's area.

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ANOTHER VIEW OF THE GROUP OF STALAGMITES KNOWN AS THE TOTEM POLES (SEE ALSO ILLUSTRATION ON OPPOSITE PAGE)

Note the exquisite formation resembling a fringed shawl, on the extreme right.

© Ray V. Davis

A GROUP OF "LILY PADS" IN THE BIG ROOM

Basins such as this, some of them 10 feet deep and 50 feet in diameter, represent the same formation as the still-flowing Biscuit Spring of Yellowstone National Park (see text, page 30).

and very inconspicuous aperture. Here we give it scarcely a second thought and pass on to the more impressive features which appear at each turn.

As we proceed we gradually make our way deeper and deeper into the earth. For nearly a mile, or a distance almost equivalent to that between the White House along Pennsylvania Avenue to the Capitol, in Washington, we traverse a passage of astonishing dimensions. The walls are very irregular, approaching to within 100 feet of each other in a few places, then receding in lateral chambers many times that width. At the side of the passageway are many alcoves opening into rooms, few of which have ever been entered and not any of which have ever been described.

In most places the walls are rough and jagged, where masses of rock, now lying on the floor, have fallen. But in a few places the walls are relatively smooth, having been polished by waters which flowed through this passageway ages ago.

There is relatively little dripstone in this part of the cave. And yet every now and again, as a beam of light is directed into the darkness, one is startled at the sight of a snow-white figure perched on some rock, like the proverbial ghost on a tombstone. These are stalagmites built up by the slow dripping of water charged with carbonate of calcium from the limestone of the roof. A few of these stalagmites like Yeitso's Pillar (see illustration on page 10) have been built up into magnificent fluted and ornately decorated columns, as if supporting the ceiling of a vaulted cathedral of vast dimensions.

In a few places the deposits of carbonate of lime have accumulated against the side walls, where water trickles from the rock. The lime carbonate, released from solution on entering the open cave, has accumulated in masses which resemble ice that forms on a cold winter's day near a stream of flowing water. Some of these "cascades frozen in stone" are large and impressive. To distinguish this material from that deposited by dripping water, it may be called flowstone.

But these formations, both of flowstone and of dripstone, are so much more

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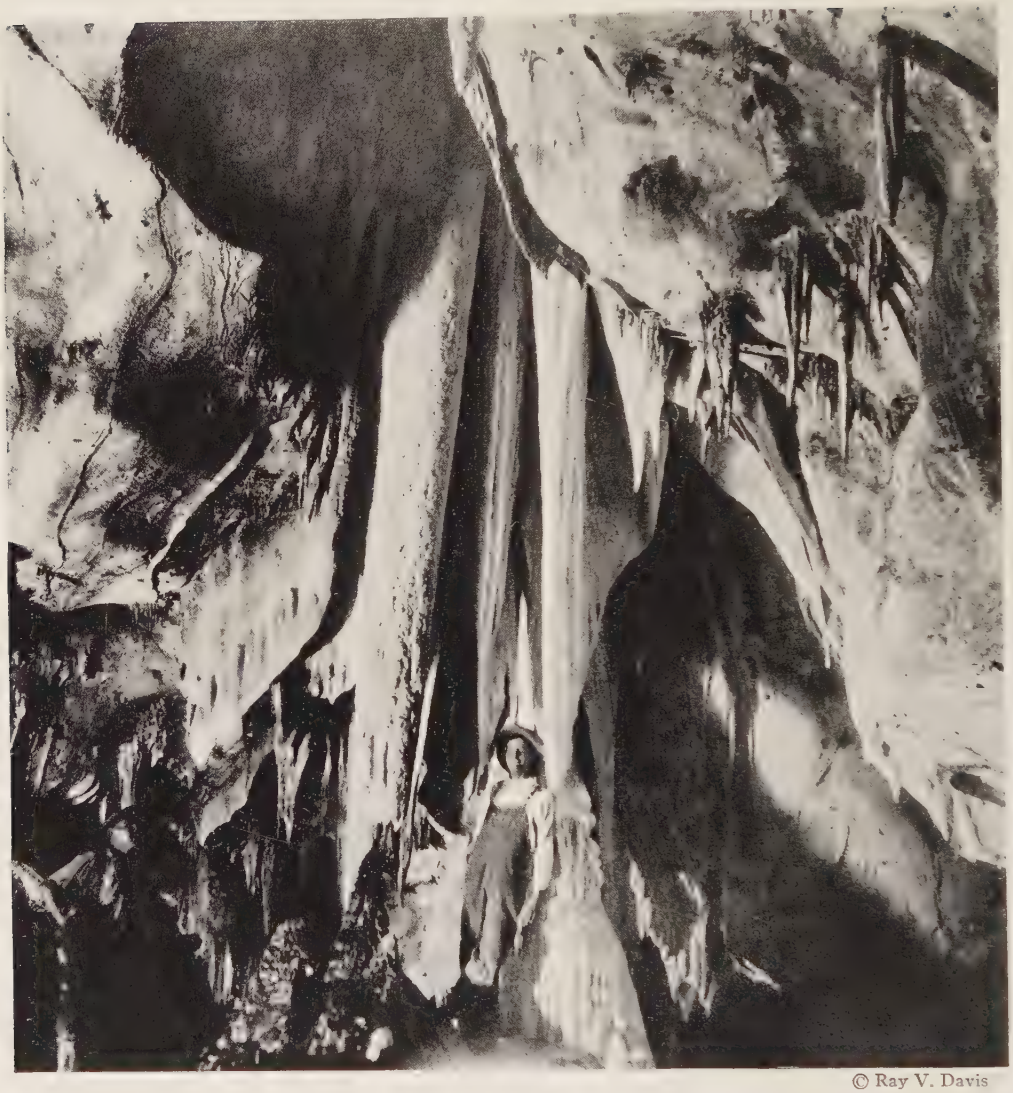
THE "CROW'S NEST" THICKET OF SLENDER STALACTITES AND STALAGMITES

This room, which is 50 feet broad, is so thickly set with these bamboolike formations that one cannot pass through it without destroying scores of them (see text, page 27).



© Ray V. Davis

THE "ELEPHANT EAR" AND "PORCUPINE WALL"

The piece which won the first nickname is the curved sheet over the figure, thinning toward the right to a knife-edge. The spikelike stalactites on the overhanging wall are unusual.

numerous, varied, and ornate farther on, that we hasten over this first part of the journey, even though, were it not for the more spectacular scenes beyond, this part of the cave would probably be regarded as worthy of extended notice.

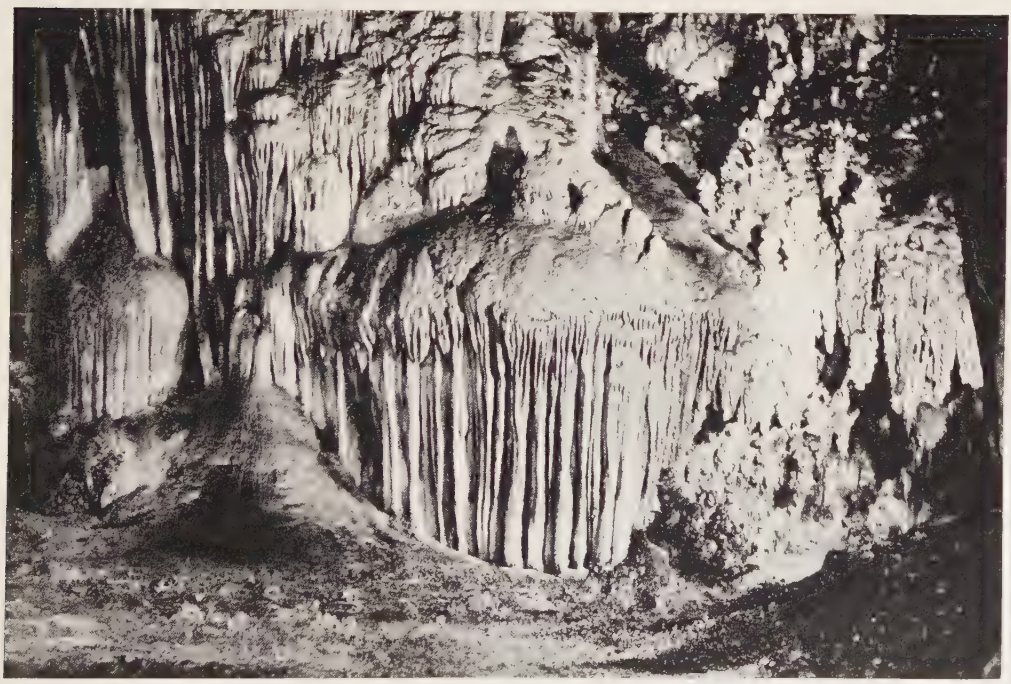
A PIT YAWNS IN EXPLORERS' PATH

Thus far the journey has been relatively uneventful; but nearly a mile from the foot of the shaft, or a quarter of a mile from the natural opening, a real difficulty is encountered. Here the floor of the cave has not been built up as far as on either side, so that a pit something more than 150 feet deep and extending entirely across the cavern suddenly yawns in our path. This hole has been called Yeitso's Den, a name which recalls the Navajo Indians' mythical monster whose blood formed Red River (the Colorado) and congealed in some places in lava flows, when he was slain by the great god Sun.

The sides are so steep that footholds must be cut, and a wire somewhat

THE CHANDELIER OF A THOUSAND PENDANTS

This enormous drop is notable for the numerous slender pencils and the broad, thin, curved sheet of onyx in the upper left center of the picture.



Photographs by Willis T. Lee

THE BLANKET OF NALIN, APACHE GODDESS OF DEATH

In many parts of the Cavern Nature has traced her designs in snow-white onyx with such exquisite delicacy that the beholder feels the stirring of a breeze would set them fluttering.

© Ray V. Davis

A FALLEN GIANT

This great mass was jarred loose from the roof; whereupon it became the base for the newly formed stalagmites, at the top of the picture. Another generation of stalactites may be seen at the left.

© Ray V. Davis

A PROFUSELY ORNAMENTED CORNER IN THE CAVERN

Mindful that the Romans peopled caves with nymphs and sibyls, and that to the Greeks they were temples, Mr. Lee would draw upon Indian mythology in naming the compartments of Carlsbad Cavern. He suggests that this chamber be called Shinav's Wigwam, for the great wolf god of the Navajo, whose broken arrows are now found as petrified tree trunks. The Petrified Forest of Arizona is said to be the battle ground of Shinav.

Photograph by E. O. Wooton

SPECIMENS OF SPANISH BAYONET IN THE DESERT OF NEW MEXICO

There are more than a dozen species of yuccas on the arid spaces in the American Southwest and Mexico. The *Yucca elata*, shown here, has leaves twenty or thirty inches long, ending in a sharp point. The trunk is covered with a thatch of the dried pendant leaves and the roots penetrate deep into the soil. After the blooms have fallen, the fruit comes as an oblong capsule, ending in an abrupt point.

insecurely anchored furnishes a handhold of questionable value.

Let the man of unsteady nerve, whose foot is untrained for difficult climbing, keep out of Yeitso's Den until a safe passageway is constructed. Into this den we slide and otherwise lower our weary bodies to a shelf beneath which the pit continues into the blackness to some unknown depth.

After a brief rest, we start the ascent out of the pit, but fortunately the rise on this side is only 90 feet. Possibly the inky blackness is advantageous here, for the torches illuminate only one difficulty at a time. If the whole 90 feet of that ascent were illuminated at once, few tourists would see the marvels awaiting them beyond. Only a hardy climber would undertake it. We draw our weary feet up from shelf to shelf, securing a handhold here and a doubtful toehold there, as a minute niche in the rock or some tiny projection is patiently indicated by the guide.

Our labors are by no means at an end when we reach the top, for almost immediately we start down another declivity, clambering over angular rocks and crawling through low, narrow passages.

Soon after leaving Yeitso's Den we enter the spectacular part of Carlsbad Cavern. Here we find chambers of unbelievable dimensions. Our way leads ever downward, over enormous jagged blocks of limestone fallen from the roof. One of these blocks, estimated as more than 100 feet in diameter, is partly buried by smaller falls. It creates much trouble, for our pathway, if such it may be called, leads under and over and around the blocks, ever downward through the jumbled mass. One of the party jocularly likens us to a train of ants making its way through a brick pile.

The chambers in this part of the cave are several hundred feet wide and the vaulted ceiling so far above us that in some places we are not able to see it, much less estimate its height. It seems like gazing upward on a cloudy night. Our feeble lights only magnify the void.

A REGAL CHAMBER AND ITS ANTEROOMS

At the foot of a great heap of rocks 700 feet below the surface at the entrance, we enter one of the spectacular parts of Carlsbad Cavern. Three large chambers here open off the main hall. The largest may be called Shinav's Wigwam in honor of the kingly warrior of Navajo mythology. Because of its size and the glory of its decoration, this great chamber may appropriately be likened to the glorified wigwam of the great wolf god Shinav, who in battle used petrified trees for arrows.

The third and smallest of the three rooms is subcircular in outline and is 160 feet long by 140 feet wide. The middle room is about three times this size and the first one much larger. No measurements were made of the larger rooms.

CURTAINS OF GLEAMING ONYX

The chambers about the Wigwam are separated from the master room by curtains and partitions of gleaming onyx formed by deposition of lime carbonate from waters dripping from the roof. The great dome is so high that it is only dimly illuminated by the torches.

Most of the ceiling is covered with dripstone. Thousands of stalactites hang singly, in doublets, in triplets, and in groups. They range from a few inches to lengths representing the entire height of the room, and in diameter from that of a small pencil to masses many feet thick. In some places they hang so thickly that they coalesce at the top, forming spiny masses weighing thousands of tons. One observer likens these bristling clusters of sparkling onyx to porcupines in postures of defense.

The stalagmites are not so numerous as the stalactites in this group of chambers. There are some notable masses of onyx rising as mounds and monuments from the general level, but over surprisingly large areas, the floor is smooth and one can wander at will under and among the myriads of pendants, until the eye tires and the mind flags. A few objects of wonder are inspiring, but too many become wearisome.

In places the stalactites have grown together laterally and formed "curtains." Some of these reach the floor, others seem partly raised to reveal a stage set with actors of fantastic aspect. Fortunately, this cave is so little known that the

Photograph by Willis T. Lee

WHERE THE WALKING STICKS COME FROM

This cactus (*Opuntia imbricata*) is a characteristic plant in southern New Mexico. It is commonly called cane cactus because of its use in making walking sticks.

Photograph by F. E. Lloyd

A NATURAL BIRD SANCTUARY IN A FRIENDLESS LAND

The spiny branches of the cane cactus afford safe shelter to birds and are used extensively by them for nesting. Predatory animals in search of eggs or young birds usually go hungry rather than brave the needle-like cactus spines.

unusual forms have not yet been marred by fantastic names born of an overstrained imagination.

No chasm yet bears the name of Pluto, and Diana seems never to have bathed in any of the fountains; there are no Tombs of the Martyrs, and even Cinderella seems never to have visited Carlsbad. It is to be hoped that these worthies will remain absent and that appropriate names may be given before the cavern is opened for general tourist travel.

One member of our party suggested that, as the cave is in territory recently inhabited by Indians, the myths of these tribes, which have already been drawn upon for some names, might appropriately furnish all names for the objects within it. The list of Indian deities and fabled heroes might be utilized and some of the natural monuments might be named in commemoration of their fabled deeds.

Photograph by Willis T. Lee

CENTURY PLANTS IN FRUIT AND CREOSOTE BUSH ON THE PLAIN EAST OF GUADALUPE MOUNTAINS

The generic name of the creosote bush (*Covillea tridentata*) was given in honor of the botanist, Dr. Frederick V. Coville, Chairman of the Research Committee of the National Geographic Society.

In some places the dripstone of the curtains reaches the floor and forms solid partitions between the rooms. Some of the side chambers are entered through narrow openings in these partitions; others through wider passageways.

A ROOM MORE THAN HALF A MILE LONG

One small chamber off Shinav's Wigwam has been called the "Crow's Nest." It is 50 feet in diameter and so thickly set with slender stalactites that one could not pass through it without destroying scores of the delicate pendants. The stalagmitic growths rising from the floor are scarcely less varied and delicate.

The most spectacular part of the cavern is reserved as the final scene of an eventful trip. Leaving the Wigwam, we retrace our steps for a short distance, climb a steep hill, make our way laboriously at snaillike pace through heaps of fallen rock and over ledges where the guide patiently shows the bewildered climber which foot to put forward in order that the next step may be taken safely. After a half hour's struggle we enter the Big Room (see illustrations, pages 4 and 12).

SOTOL PLANTS NEAR THE MOUTH OF CARLSBAD CAVERN (SEE TEXT, PAGE 32)

Photographs by Willis T. Lee

ROCKS AND DECORATIONS IN THE LAST CHANCE CANYON

The ancient rocks of the canyon wall (to the right) are draped at the left with a thick mantle of lime carbonate, deposited by the water which in ages past issued from the mouth of some cave. The waters no longer flow here, having found an easier passageway through the rocks. The mantle of flowstone remains, decorated by ferns, green shrubs, and a rosette formed by the bristling spikes of a century plant.

Photograph by William Edwin Safford

A CACTUS IN BLOOM

This cactus (*Echinocactus horizonthalonius*) is common near the mouth of Carlsbad Cavern. The fleshy mass of the species is used in the manufacture of candy.

I doubt if a name more appropriate than Big Room could be found for this remarkable opening. It is more than half a mile in length and will probably average many hundreds of feet in width. The sides recede in places to such great distances that our lights failed to illumine the walls. A few side trips revealed alcoves uninterrupted for hundreds of feet, but none of these has been thoroughly explored.

Repeated effort was made to obtain some concrete idea of the height of the irregularly arched ceiling. In a few places the rocks above us were revealed by the torches, and it was estimated by several members of the party as more than 200 feet above us. In other places even the spotlight from a strong electric torch failed to pierce the gloom and no ceiling could be discerned.

The Big Room has astounding proportions. Had I been told before entering it that an open space of such great dimensions was to be found underground, I should have doubted my informant's word as frankly as many of my readers probably will doubt mine.

Some visitors who claim familiarity with noted caves assert that Carlsbad Cavern surpasses all others in size and in the beauty and variety of its decorations. It seems probable that this claim may be substantiated when an adequate survey and extended examination are made.

NATURAL DECORATIONS OF DELICATE DESIGN

The Big Room is probably as remarkable for ornate decoration as it is for size. Dripstone decorations occur in infinite variety of size and shape. There are thousands of pendants, some so delicate and slender that they break under the slightest pressure; some so massive that one marvels that the enormous weight is sustained.

The stalagmites, rising from the floor like monuments in a churchyard, are no less varied. One group, in which the forms are unusually tall and graceful, has been called the Totem Poles. Some, only a few feet in diameter, rise to an estimated height of 50 feet (see page 16).

Many of the stalagmites in this part of the cave have blunt, rounded ends and are

Photograph by E. O. Wooton

ONE OF THE NUMEROUS SPECIES OF SOAPWEED OF THE SOUTHWEST

The *Yucca baccata* is one of the numerous species of plants of the southwestern part of the United States containing saponin, a chemical found in the roots, stems, and other portions of the plant which removes dirt from hair and woolen goods. A machine has recently been invented which chops up the stalks of several varieties of yuccas to be used as emergency food for cattle.

composed of material which seems to differ from that of the surrounding forms. They appear dark-colored and contrast sharply with other forms in having a smooth surface in place of the chalky white frostwork surface which is more common.

In the dim light these rounded masses resemble ice—a resemblance which becomes somewhat realistic when one undertakes to climb over the wet, slippery surface.

Some of the stalagmites are of unusual dimensions. The "Twin Domes" are said to be more than 100 feet high and to measure more than 200 feet across the base.

This base is a mammoth dark-green mound having a wet, slippery surface. The mound is surmounted by the two conspicuous pillars of light cream color, covered with myriads of tiny grooves and projections, which cause them to sparkle and glitter as the torchlight plays on them.

Some of the most interesting features in the floor of the Big Room are grouped about the basins of extinct springs. Some of the basins are 10 feet or more in depth and perhaps 50 feet across. They are lined with an unknown thickness of onyx and in their profuse decoration closely resemble some of the hot springs in Yellowstone National Park.

If the Biscuit Spring in Yellowstone were drained, leaving the surrounding crust of mineral matter undisturbed, it would resemble one of the basins in Carlsbad Cavern. The interior of each fountainlike basin is covered with delicate fretwork, and the rim appears now just as it was built out long ago by overflowing water, into a variety of forms.

A type of decoration frequently seen is called by some toadstools, and by others is likened to lily pads. Each pad consists of a thin sheet of onyx which grew from a center in concentric rings outward to a knife-edge. These sheets are a foot or

Photograph by Willis T. Lee

AN ANCIENT BURIAL PLACE

The wall of Last Chance Canyon, near Queen, New Mexico, shows openings in the limestone of the canyon wall where bones of prehistoric men were found. Few of the openings have been examined, as they can be entered only with ropes and ladders. Some of them may lead into caverns. In these well-protected shelters the ancient inhabitants of the Guadalupe Mountains, who lived and died before the time of Indian occupation, tenderly laid away their dead in baskets made of the leaves of the sotol plant (see text, page 32). Some of the bones and baskets have been taken from these sheltered nooks; others remain untouched. The sotol plant has survived its ancient users and still thrives in these mountains. One of these plants appears prominently in the foreground.

two across and each rests on a strong pedestal. The edge of the "lily pads" represents the former level of the water in the fountain. Now that the basin is dry, they stand forth like campstools.

Our entire party entered one of these dry fountains. Each member selected the camp chair which best suited his fancy and seated himself on it for a few minutes' rest before resuming the journey (see page 18).

In many places stalactites and stalagmites have joined to form columns of impressive dimensions. No measurements of them have been made. I hesitate to estimate the height and diameter of these great pillars. Some day they will be measured. I can only say that they impress me as very high, very large, and very astonishing (see page 11).

Near the end of the Big Room is a small opening in the floor for which the name Nalin's Hogan has been suggested, as in Apache myth, Nalin or Night Girl is the Goddess of Death. Into the Hogan, or earth lodge, the guide, Mr. White, was once lowered about 200 feet at the end of a rope. There he found other chambers and hallways, through one of which flows a stream of clear water.

At the extremity of the Big Room the floor falls away abruptly to a depth of about 100 feet in a great depression 200 feet across. Some have applied the name Dante's Trail to this hollow; others call it Shipapu's Hole. The latter name recalls the hole in the ground where, according to Indian myth, the Pueblo Indians originated.

At Shipapu's Hole our pathway suddenly ends. No man has ever yet ventured into this great sunken portion of

the cavern. Here, too, our journey ends, for the guide reminds us of the difficulties in retracing our steps. Reluctantly we return, snatching hasty glimpses of scores of objects as fascinating as those already seen. The surface is reached just at dusk, where, in spite of the hard homeward journey ahead, we watch for a time the swarm of bats leaving the cavern.

AMONG MOUNTAINS OF RUGGED BEAUTY

The cavern alone is a noteworthy addition to the exceptional variety of geographical wonders of the United States, each distinctive of its kind, but fortunately it is surrounded by features which enhance its future scenic value. Few persons now traverse southeastern New Mexico and few realize that mountains rise there to altitudes of nearly 10,000 feet. Moreover, these mountains are carved, by erosion, into a remarkable series of sharp ridges and steep-walled gorges which are scarcely surpassed for rugged beauty.

The rocks of these mountains consist of limestone of late Paleozoic age, in thick, massive layers which slope gently in an easterly direction and pass under red sandy shale in Pecos Valley. The shale contains thick beds of gypsum and rock salt, which dissolve in the circulating underground water.

The limestone also is soluble, but less readily than the salt and gypsum, and because of its greater resistance to the action of the water, the caverns in it are formed slowly, but become enormously large, and endure through long ages.

Carlsbad Cavern is only one of a dozen or more known to exist in Guadalupe Mountains, although little aside from their mere existence is known of these, even locally. Here is ample opportunity for adventurous spirits who are looking for unknown regions to explore.

The plants near Carlsbad Cavern are of great interest to those unfamiliar with the Southwest. This part of New Mexico has a warm, semi-arid climate in which thrive a variety of plants of amazing shape. These give to the landscape a strange aspect that is a source of never-ending delight to the visitor. However, to those for whom the novelty has worn away, these weird forms of vegetation are sources of annoyance and discomfort.

The predominating characteristic is thorniness. There are thorn bushes and thorn trees; thorned shrubs with spike-like leaves; Spanish bayonets and Spanish daggers. This is a country of prickly pears and cat's claws; sagebrush and greasewood; thorny mesquites and screw beans, and many less familiar but no less interesting forms of plant life.

The beauty of a cactus in bloom and of the great flower stalk of the century plant is well known, but the equally gorgeous appearance of many of the other plants when in fruit or in flower is less familiar.

Probably the most interesting plant near Carlsbad Cavern—certainly the most prolific one—is the sotol, of which there are many closely related species. The one which grows luxuriantly near the cave and adorns the barren, rocky slopes is known as *Dasylirion leiophyllum*. It consists of a spongy base a few feet high, crowned with hundreds of linear leaves about a yard long and half an inch wide, armed on both margins with numerous sharp recurved teeth. The leaves thus resemble blades of a jig saw, except that both edges are armed with teeth (see illustrations, pages 28 and 38).

Occasionally a plant is seen with a fruit stalk emerging from the center of the leafy crown, but most of them are without fruit stalk, for the plant dies after fruiting.

THE SOTOL HAS MANY USES

The sotol is useful in several ways. The heart of the leafy crown resembles a cabbage; and this, as well as the spongy interior of the short, thick trunk, makes excellent food for cattle when the toothed leaves are removed and the plant split open.

Sotols were formerly used as food by the natives, who roasted or boiled the heads after removing the saw-blade leaves; also, from the fermented trunks is distilled an intoxicating drink called "sotol." The long, tough leaves are used for thatching and for making baskets, mats, and rough cordage. These uses seem to date back to very early times, for baskets and burial receptacles made of sotol leaves have been found containing skeletons of prehistoric people in caves and sheltered nooks high in the canyon walls of Guadalupe Mountains.

Photograph by Frank M. Campbell

A FLOWER SENTINEL AND ITS NATURAL PEDIMENT

Sotol (*Dasylirion wheeleri*) is a desert plant of the Lily family. From the center of its stiff linear leaves rises a solitary stem terminating in a large spike of inconspicuous flowers. The leaves are chopped off, and the fleshy heads formed by their bases are baked for food and used as the source of an alcoholic liquor of fiery strength, called sotol (see text, page 32).

Photograph by Frank M. Campbell

THIS PLANT IS A BOON TO INDIANS

The Saguaro, or Giant Cactus (*Carnegiea gigantea*), usually has two or three branches, when young only a single shaft; this is an exceptionally tall and multi-branched specimen. The fruit and seeds provide food and drink for the Papago and Pima tribes (see also page 35).

Photograph by Frank M. Campbell

A SPECIMEN OF THE CANCER CACTUS

This form of the Giant Cactus (*Carnegiea gigantea*) is locally called Cancer Cactus because of the abnormally branched top. It is a variation of the type shown on page 34, and is abundant in certain parts of southern Arizona and Sonora, Mexico.

Photograph by Frank M. Campbell

A SAHARA OF GIANT CACTUS

A scene in the southern Arizona desert. A Mexican with his pony and old buggy ambles along the road. The desert frequently is far from being the barren, inhospitable, drab place of popular imagination. In the spring, especially, this area abounds in flowers of many colors, which are of great interest to the botanist, and some of the plants have a high economic value.

Photograph by Frank M. Campbell

THE WHITE CHOLLA

The figure of the woman gives a scale to show the height to which this plant (*Opuntia fulgida*) sometimes grows. It is common in southern Arizona and northern Sonora. The fruit, which is not edible, commonly grows in chains and persists for many years. A new fruit forms at the terminal end each year.

Photograph by Frank M. Campbell

TWO LILIES OF THE DESERT

These flower clusters of the Yucca (left) (see also page 40) and the Sotol (right) (see also page 33) show the respective sizes of two excellent specimens. Both of these plants belong to the Lily family.

Photograph by Frank M. Campbell

A CACTUS THAT PROVIDES WATER

An Arizona Water Cactus (*Ferocactus wislizeni*) 7½ feet high. This species is the friend of the desert traveler, because it yields drinking water during long rainless periods. The water is squeezed from the pulp like cider from apples.

Photograph by Frank M. Campbell

A TREE LILY (*Yucca elata*) IN FULL BLOOM (SEE PAGE 38)

This plant furnishes fiber which is put to various domestic uses by the Indians of the Southwest.

ADVENTURES AMONG THE "LOST TRIBES OF ISLAM" IN EASTERN DARFUR

A Personal Narrative of Exploring, Mapping, and Setting Up a Government in the Anglo-Egyptian Sudan Borderland

By Major Edward Keith-Roach

With Illustrations from Photographs by the Author

The mid-Africa region of great plateaus and fertile oases which this vivid narrative describes has been visited rarely, and many curious customs of its interesting peoples are here described for the first time. The author was District Commissioner of Eastern Darfur, part of the Anglo-Egyptian Sudan, from 1916 to 1920. During that time he made excursions into various parts of his remote province and mapped areas hitherto blank on the maps. He also bears the title, "Late Bimbashi, Egyptian Army."—The Editor.

WHEN Lord Kitchener, in 1899, had marched his victorious army, composed of British and Egyptian troops, into Khartum the reconquest of the Anglo-Egyptian Sudan was practically completed, and the work of reconstruction and administration was quickly begun. British officials were placed in charge of each province with the exception of Darfur, the most westerly province, of about 170,000 square miles, which was left entirely under the jurisdiction of its own Sultan, Ali Dinar. His only obligation was to pay a small tribute yearly to the Governor-General in Khartum.

That is the reason why I was in Darfur from 1916 to 1920.

When Turkey entered the World War she called upon all devout Moslems to join her in "the holy struggle against the infidels and dogs of Christians."

FLAG AND SPEARHEADS WERE WAR DECLARATION

The Senussi tribe, on the western boundaries of Egypt, accepted the call and themselves attacked Egypt, which made it necessary to station a fair number of Allied troops in the oases along the frontier. They also succeeded in sending envoys with autographed letters, decorations, and jeweled swords from the Sultan of Turkey across the desert by the Arbain road, the Road of Forty Days, to Sultan Ali Dinar and persuaded him to join them in the "fight for freedom."

Ali Dinar sent off a flag and three spearheads to the nearest British official in the neighboring province as a polite intimation that he was ready to enter the lists. He then mobilized his slave army and sent skirmishing parties to molest the inhabitants of Kordofan.

These raids became so frequent and menacing that it was decided to occupy the territory, and in 1916 a small expeditionary force, consisting of Egyptian Army troops, led by British officers, and accompanied by a handful of British machine gunners, marched 400 miles along an almost waterless track. After two small battles the country was under the British flag.

The biggest engagement occurred just outside El Fasher, the capital of Darfur, in May, 1916, and the Sultan, who fled from the city as soon as the news of the reverse reached him, was killed in action in the hills six months afterward.

Unfortunately, I saw none of the fighting. After joining the Egyptian Army early in the year, I was sent to Port Sudan, on the Red Sea coast, in connection with the Arab revolt in Arabia, and it was some months before orders came that I was to proceed to Darfur and take over the administration of the eastern

OMDAS AND SHEIKS OF DARFUR

These men have performed exceptionally good service for the state and have been awarded robes of honor by the Governor-General of the Sudan.

HOW THE UNION JACK AND THE EGYPTIAN FLAG ARE CARRIED WHEN TREKKING

district, the boundaries of which were undefined, but were roughly supposed to enclose an area of twenty to thirty thousand square miles.

REACHES ISOLATED HEADQUARTERS

From Port Said I railed to Khartum, and after two days spent in getting provisions for my long solitude, which was to last more than three years, I took the train to El Obeid, about 350 miles southwest, where camels were purchased to carry me and my baggage some 300 miles to my future home.

Um Kedada was the name of my headquarters, and after three weeks' trekking I was told early one morning we were approaching the place; so, pushing my camel on ahead of the escort, I mounted the last sandy hill and found—a few native soldiers and a well.

The journey was long and tiring. We marched practically all and every night except for a couple of hours at midnight to rest the camels. We tried, while the camels grazed, to sleep during the day under what shade could be found from a tree, but continually had to move the position of the camp bed as the relentless sun mounted higher in the heavens. The heat at midday varied between 110 and 120 degrees Fahrenheit in the shade, but was much more intense in the sun.

At varying intervals the track was strewn with grim relics of former camel caravans. Supercilious in life, the camel is even more so in death. Lying on his side, his upper lip drawn back, his head thrown up until it almost touches the hump, he shows by every attitude his utter contempt for the world he has left behind.

ALONE IN THE DESERT BY NIGHT

Marching at night has a fascination all its own. My camel, being lightly laden and speedier than the others, generally outstripped them all, and I was alone in the beauty of the African night. A full moon gave light enough to read by, and a breeze from the north would blow across the sandy plains, making every blade of grass bow its rustling head. Here a cricket chirped, there a ringdove cooed to its mate, and beyond an owl hooted as he transferred his quarters from one tree to another. And so on for mile after mile, the soft pad of the camel was scarcely perceptible, even in the silence of the night.

Occasionally I passed native caravans and the courtesies of the road were

BRITISH HEADQUARTERS IN EASTERN DARFUR, CONSTRUCTED OF MILLET STRAW

exchanged: "Keif halak? Taiybin! El hamd el Allah. Maa-salaamih." (How are you? Well! Praise be to God. Go with safety.) Ghostly voices coming out of the night!

Early in the small hours the moon disappeared, leaving momentarily a red glow in a haze of palest lilac. For the next hour or so, there being no competitor, the stars shone with renewed splendor on the darkened world, and once or twice a meteor shot half across the heavens, leaving a trail of fire. Toward 6 o'clock the east was flooded by palest rose pink, and a few minutes later the sun was up. The spell was over, life became real again, and I instinctively felt for my helmet and looked round for a place to camp.

BUILDING IN TOPSY-TURVY LAND

Um Kedada, which was a military base for our army on the march up to El Fasher early in the year, stands on high ground with a fair outlook, surrounded by escarpments of low-lying hills. Its chief call to fame is a most excellent water supply—an invaluable asset! The well, broad and fairly deep, is lined with rough stone halfway down, and was dug many years ago at the instigation of an old sultan, who made a chain of wells leading into Kordofan to assist his raiding parties, which periodically sallied forth after his neighbors' cattle. The old method of lining is now, alas, a lost art among these people.

It is difficult adequately to picture what a well means until one has lived near the Sahara. In my 300 miles I passed two places only where there were any, and on my arrival at Um Kedada I had been for six days subsisting on what water I could carry on my camels; they had been all that time without a drink.

Greetings made to all assembled at the well, animals watered, and men rested, I looked round for a convenient place to build a temporary house.

In a land of opposites, where one writes from right to left, takes off one's shoes and leaves the hat on when entering a house, we naturally begin building at the roof and build downward. Native *tukls*, or huts, are made from dried millet stalks and are shaped like straw beehives, but are finished at the top with little tufts.

AGRICULTURAL IMPLEMENTS USED IN DARFUR

The half-moon shaped hoe is used in weeding millet; the other implement is a branch of a tree, bent at right angles, used in planting the grain (see page 61).

THE "RAHAD" IS THE FASHIONABLE ATTIRE FOR DARFUR GIRLS

This garment consists of strings of leather hanging from a belt. Boys wear a sacklike shirt of rough cotton cloth, with holes for their arms (see text, page 58).

Drawn by A. H. Bumstead

A SKETCH MAP OF AFRICA SHOWING DARFUR

They look for all the world like wooden whip tops upside down.

Eight long branches are placed with ends on the ground, tied together in the center, and laced round with smaller branches until the structure looks like an army bell tent. This is the roof, which is then thatched with millet straw from the bottom upward and tied together tightly at the top into the little tuft.

This superstructure is then raised up on poles set in a circle with a V at the top, standing about four feet out of the ground. The sides are then thatched and the palace is ready for occupancy. Doors and windows are a trouble, owing to the constant wind that blows in the sand at all times of the day and night; so windows are dispensed with, and a kind of hurdle, placed on the windward side, serves for a door.

A cavalcade of horse, infantry, and camel men, led by two British officers, bronzed and burnt by months of trekking, filed slowly through Um Kedada on its long journey from El Fasher to Khartum.

As the eye traveled from end to end of the long brown line, it was arrested by a wonderful blaze of color in the center of the column.

A SHEIK AND HIS HORSE DECKED OUT IN GALA ATTIRE

There were some twenty men mounted on camels, and their gorgeous dresses scintillated in the rays of the western sun. Here a purple *djibbah* (cloak), there a strawberry-colored one, a bright yellow one farther back, but at the head of all was an imposing figure in green and gold with a colored turban. Who were these men? What were they doing between the ranks of the Arab soldiers?

A CRIPPLED REMNANT OF SULTAN'S RULE

They were the legitimate sons of the late Sultan Ali Dinar, and the figure at their head was Zakariah, the eldest son, who but for his father's misrule might have been sultan after him. As one watched the imposing cavalcade go by, a twinge of sadness crept round one's heart; another native-ruled state had ceased to exist, and one felt a lurking sympathy for the eldest son, leaving his father's kingdom. But the feeling was checked by hearing the wheezing of a native near by. Every breath he took appeared to be almost his last; his chest was emaciated and seemed driven into his back. This was his tale:

"Two years ago the Sultan stopped here for a few days, and I, among others,

FOUR GENERATIONS OF MEN OF DARFUR

was told off to guard Ali Dinar's camels. One of them unfortunately broke its hobbles, strayed away, and could not be found at the moment of departure. The Sultan ordered me before him and his son Zakariah, and had me beaten with a heavy pole—back, chest and legs."

Two years after, by my side stood the victim—a hopeless invalid for life.

A son had lost his inheritance, but a people were delivered from bondage.

The army's work in Eastern Darfur being completed, the small detachment of Sudanese soldiers left for other fields.

To bring them good luck, thirty piasters, about $1.50, were donated by Europe's only representative to purchase a sheep.

As the order to march was given, the "lucky" animal was dragged into the gateway of the *zereba*, a knife flashed out, the jugular vein was severed, and the men, from column of fours formed two deep, then single-filed, and each stepped carefully, happily, proudly, over the dying, pulsating body. A job well done, the men stood ready to bring honor to their regiment in other theaters of action, or else to dwell awhile with their families and recount their deeds of 1916.

Martial law had ceased; civil administration reigned in its stead.

FROM LEFT TO RIGHT, MOTHER, DAUGHTER, GRANDMOTHER, AND GREAT-GRANDMOTHER IN DARFUR

Our temporary dwelling finished, the work of creating a town started in earnest.

TOWN PLANNING IN NOMAD REGION

This was planned in lots of 197 by 197 feet, with roads running north to south and east to west, of 65 feet and 32 feet, alternately. On each of these plots nine tukls were allowed to be built, and a man was appointed head of the plot to see that it was kept in a sanitary condition. Natives gradually collected from the surrounding hamlets to be near the well, and a town of 500 or 600 people soon sprang up, including a few pilgrims from Nigeria, about whom I shall say more later. People did not formerly live near the highway for fear of being raided by passing bands.

Two native builders of more or less doubtful value came up from Kordofan Province, and we opened up a new industry—brick-making.

Our methods were somewhat crude, but the result was a fairly solid brick that proved an advance on millet straw. Sandy clay mixed with water was put into a mold made from old provision boxes, and the bricks were turned out and dried in the sun.

Meanwhile foundations were dug for the offices, stores, a prison, and official houses.

Lime and cement were not procurable, so mud was used for plaster and proved an effective substitute.

A wanderer arrived who had a slight knowledge of carpentering, so he was drawn into the mesh and, with the help of primitive tools, produced presentable doors and windows from forest wood and old packing cases.

Timber for the roof had to be brought up many miles on camel-back, as nothing long enough grew in the vicinity.

Old rifle barrels were used as bars for the prison windows and proved most serviceable.

A SHEIK AND HIS FAMILY HEIRLOOM

With the buildings half up, a heavy tropical rainstorm, entirely out of season, did much damage, but eventually all was successfully accomplished.

One morning four camels, groaning

A DANCING DERVISH OF DARFUR

ENTERTAINING AN OFFICIAL GUEST

There was always a dance when the District Commissioner visited a village. The star of this performance is a girl who bends backward until her forehead touches the ground.

DANCING BEFORE A BRIDE

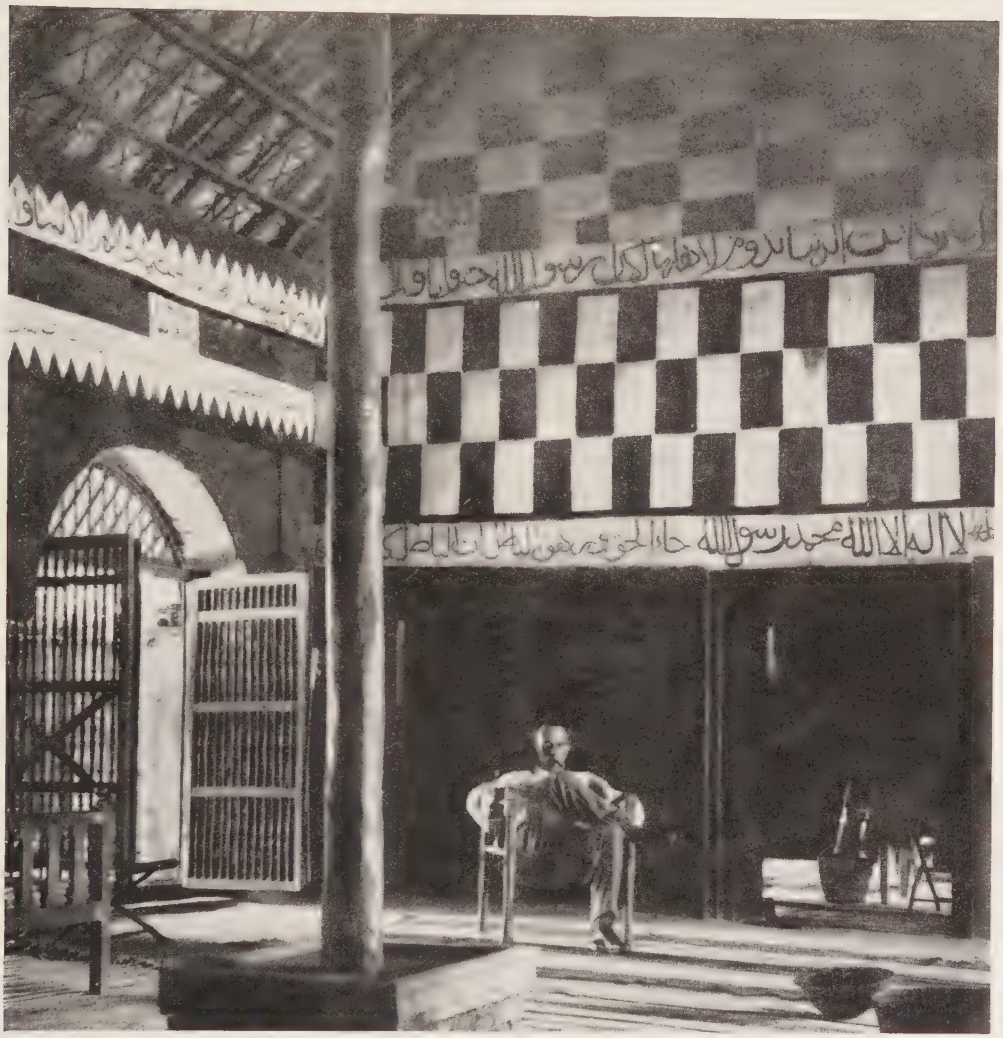
ORCHESTRA AND CHORUS FURNISHING ACCOMPANIMENT FOR A NATIVE DANCE

The men stand together in a row clapping their hands and humming in deep tones (see preceding page), while the girls stand opposite singing.

THE OFFICE STAFF AND NATIVE NOTABLES WAITING OUTSIDE THE AUTHOR'S HOUSE TO ATTEND A RECEPTION: DARFUR

HOLDING A NATIVE RECEPTION

In this instance the author is the host. The way in which the headman of a village receives an official visit is described on page 69.



THE HAREM OF SULTAN ALI DINAR'S PALACE AT EL FASHER, THE CAPITAL OF DARFUR

The verses from the Koran which decorate the walls may be freely translated thus: (*Top right:*) "Should the world remain eternal to its creatures, the Apostle of God would have remained alive and existing." (*Bottom right:*) "There is no God but God. Mohammed is the Apostle of God. Right has been established and vanities have vanished, for they are things that pass away." (*Left:*) "Oh God, cast your prayers upon Mohammed at the beginning and at the end; the first and last of the prophets and apostles. There is no God but God." This palace was built by a Greek who was a prisoner of the Sultan for many years.

and protesting, announced the arrival of the office fittings sent from Khartum. Their loads were dumped down, and the gentlemen in charge, relieved of their responsibility, went off to a tree conveniently near and, under its kindly shade, discussed the three really important questions in their lives—money, drink, and women.

Undismayed by the fragments of their conversation which floated across, I struggled off in the deep sand to urge the sheik who was building the office to greater efforts. Within two days the walls were finished. This sheik was a worthy soul, and the end of the rosary which he wore round his neck was adorned with a fragment of an ancient wire hair comb—a family heirloom!

The first crate produced those indispensable articles of furniture so well known in concert-rooms—four bentwood,

PILGRIMS BOUND FOR MECCA

Two years or more are frequently required for the overland journey from Nigeria to the great holy city of Islam, and along the route the travelers find it necessary to bide awhile from time to time to earn sufficient funds to pursue the pilgrimage.

DARFUR LIES ACROSS THE LINE OF MARCH OF NIGERIANS BOUND FOR MECCA

In the days of the late Sultan Ali Dinar, heavy toll was exacted from such travelers. Frequently the fairest daughters of a party were seized for the tyrannical ruler's harem.

cane-seated chairs. They had such a touch of "special terms for schools and large parties" that one welcomed them with open arms.

But, alas, they were in pieces!

Vigilant search through the case revealed eight nuts and bolts and sixteen screws, but no spanner and no screwdriver. However, the bolts were driven home and the nuts screwed on by finger-power. The screws defied all attempts with pocketknife, coin, and piece of tin, when suddenly one of the helpers had a bright idea and, rushing off to his donkey, cut off a charm hanging round its neck and produced—the business end of a screwdriver! It was small, rusty, and blunt, but I doubt if ever an artisan cherished the finest instrument in his toolbox as much as I did this veritable gift from Allah. A handle was soon made, and so efficacious was the tool that the last chair was put together in eleven minutes.

WHERE SHEIKS ARE MAYORS AND OMDAS ARE GOVERNORS

The official in charge of Eastern Darfur has to be administrator, magistrate, collector of revenue, estimator of crops for tithes, commandant of police, veterinary surgeon, surveyor, doctor, and all the other things that go to make up a well-ordered community. Consequently many months were spent in setting up the system of organization. Sheiks were appointed in charge of villages, and *Omdas* placed in authority over groups of villages and given limited powers, sufficient to enforce their orders. Police had to be recruited and trained. Roads had to be cut through the scrub or tracks widened. All this entailed many weeks' touring by camel from place to place.

Villages were few and far between, there being only about 300 in the whole district, containing about 30 to 200 people each.

The country is mostly bushy scrub and covered with a grass called *haskanect*, the seeds of which have innumerable little spikes that get into everything—food, clothes, hair, and skin—setting up nasty irritations. The natives all carry home-made tweezers to extract the spikes from their legs. This grass springs up during the rains, and a month afterward is burned brown, when the seed pods start flying about.

The sand on the tracks is very heavy and frequently, if walking, one sinks in over the ankles.

Millet is the only species of grain that

READY FOR AN INSPECTION TOUR IN DARFUR

It was a journey of 300 miles by camel transport from El Obeid, 350 miles southwest of Khartum, to the author's headquarters for the administration of Eastern Darfur, in which province, on the Anglo-Egyptian Sudan border, he remained for more than three years.

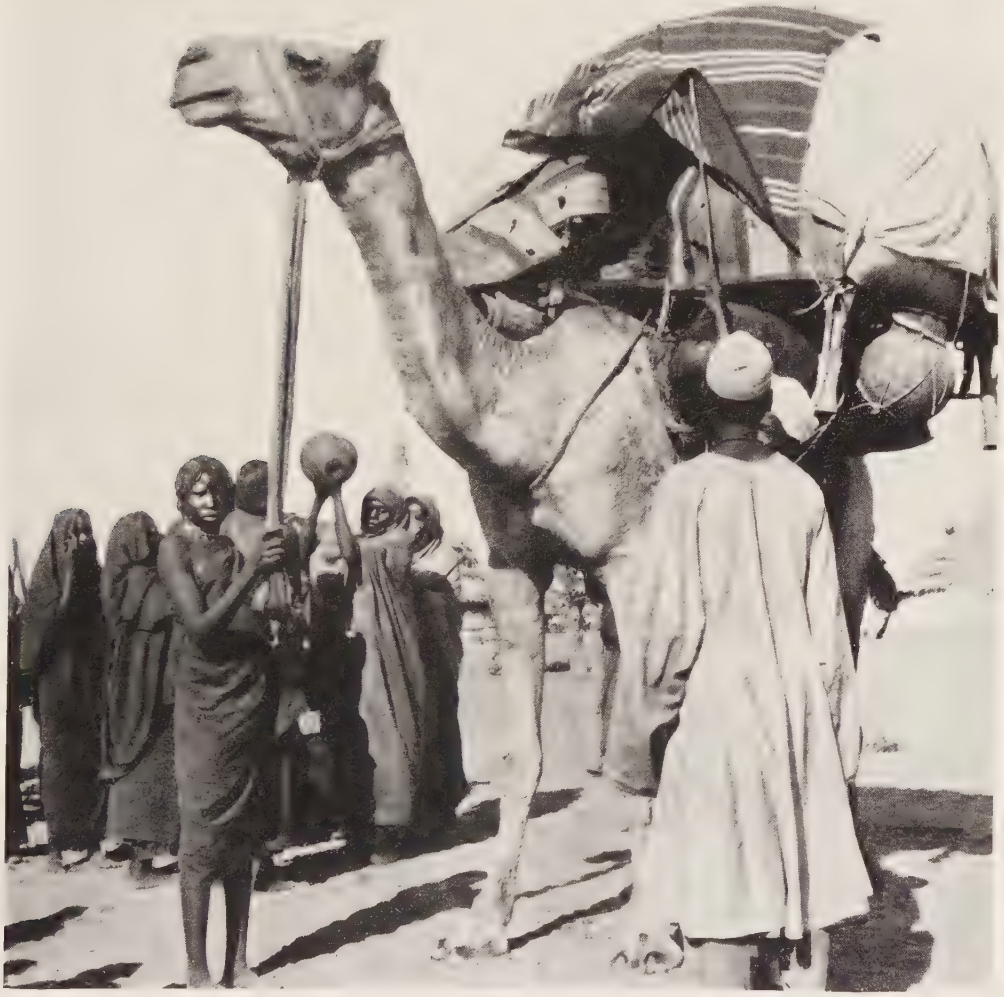
will grow in the district, owing to the poorness of the sand as soil.

I generally trekked fifteen days a month, but one long tour took me over two months. At harvest time I frequently rode enormous distances on my camels to pay surprise visits to estimators who were assessing the crops for revenue purposes.

OFFICIAL ALSO IS "MEDICINE MAN"

I took a medicine chest with me and was called upon to prescribe for every conceivable ailment, from helping a woman who could not feed her baby to restoring an old sheik's youth; from setting a broken leg to casting out a devil from an old woman who was reported to bark like a dog. As the barker refused to yield to treatment, I lighted a fire of damp straw under her bed with most happy results, and my fame as a medicine man spread far and wide.

Serious crime is extremely uncommon, and the people have such a sense of justice that I could send a verbal order accompanied by an impression of my seal—



HOW A LADY OF QUALITY TRAVELS IN DARFUR

Her bed is slung across the camel and a shelter made from the sun. In this instance the traveler is a bride going off to her husband's village.

few can read or write—a hundred miles away, visit the place six months afterward, and find it faithfully obeyed.

Practically the whole of the district was unmapped, and so when I traveled by day a man pushed a cyclometer in front while I took bearings with a prismatic compass, checking the distance traveled by the cyclometer, and plotted it on map paper while I camped at midday (see illustration, page 61).

Although the inhabitants call themselves Arabs and speak that language, they are negroids—that is, negroes with a small admixture of Arab blood which has come down through the ages.

They are Mohammedans, but as few can read or write, they are not strict followers of the Prophet, except in that both sexes respect the Ramadan, the month of fasting.

MOTHER'S BACK IS CARRIAGE AND CRADLE

The children attract attention. The babies are carried on the mothers' backs. A child is caught by the wrist and adroitly swung around to the mother's back, a leg on either side of her waist, and

A CAMEL CALF TWO DAYS OLD

While the Arabian camel stands three feet high a few days after birth, it does not reach its full growth until its sixteenth or seventeenth year, and it lives from 40 to 50 years.

is tied by a piece of her raiment, with its arms inside. There the infant stays for hours, with its little head sticking out, looking wonderingly at the world, while the mother does her work. Its hands being tied in, its poor little eyes often are covered with flies. When sun and flies become too much for its patience, it whimpers meekly and the mother throws the other end of the *tobe* over its head and waggles it to sleep.

Both boys and girls have their tribal marks cut on their cheeks at an early age, salt being rubbed in to keep the slits open. Little girls wear a *rahad,* a short skirt of strings of leather hanging from a belt, which swings picturesquely like a kilt as they walk. If there is enough rough cotton cloth to go round, the boys have a sacklike shirt with holes for their arms; otherwise they go as God made them.

Owing to the Arab invasion of northern Africa many centuries ago, the Moslem religion extends from the Red Sea to the West African Coast. It is laid down in the Koran that all devout followers of the Prophet who are able to do so must make the sacred pilgrimage to Mecca once in their lifetime.

The wealthy Mohammedans from West

THE CALF OF THE OPPOSITE PAGE A FEW MONTHS LATER

The flesh of the young camel is said to resemble veal and is a favorite food for Arabs, while camel's milk is highly prized as a beverage.

Africa take ships from those ports and go by way of the Mediterranean Sea, Suez Canal, and Red Sea to Jidda; but this route is closed to the poorer class, who, therefore, have to travel overland.

Selling all that they possess, the hardy Hausa tribesmen of Nigeria purchase as many bulls and cows as they can and set out, the children and old women being mounted on the patient beasts, upon which also are loaded cooking pots and innumerable bits of paraphernalia. The braves amble along, brandishing their throwing spears, while the oldest man carries a spear about 10 feet long to add to the dignity of his age.

TWO YEARS FROM MECCA

The journey to Mecca takes about two years. Much of the ground to be covered is practically waterless, and there are great hardships to endure.

The pilgrims follow the main caravan routes across Nigeria, on through French Equatorial Africa, approaching Darfur Province through Abeshr.

In the time of the Sultan Ali Dinar the pilgrims paid heavy tolls to him; their fairest daughters often were forcibly taken to adorn his harem, and their cattle impounded to pay imaginary taxes. The reoccupation of Darfur by the Anglo-Egyptian Sudan Government therefore is of immense benefit to these pilgrims, as they now have the protection of either the French or British governments throughout their route.

Even so, there are many difficulties to be overcome. At various larger centers the little parties settle down, sometimes for months at a time, hewing wood and drawing water or cutting grass for the more indolent Arabs, thereby earning enough money to provide them with food for the journey to the next place. At El Obeid they rest a long time, laboriously earning enough money for the railway fare to Khartum, and then proceed to Suakin or Port Sudan. Thence they are taken in Arab *dhows* to Jidda, the Red Sea port for Mecca on the Arabian coast.

A SLEEPING CAMEL

Observe the heavy sand and the size of the flies on the beast.

For some time our market place consisted of a few hurdles, balanced at great hazard on twisted poles, and the only venders were a few women who did a trade in native beer. Their sales fluctuated according to the proximity of the soldiers' and policemen's pay days.

A JUVENILE RETAILER CAPTURES TRADE

Occasionally some daring soul introduced eggs and watermelons. Then a merchant prince appeared. He was about ten years old, the son of the sergeant major of police, and had the great distinction of being able to read and write. The first day, when he established his claim, a little red pepper constituted his stock in trade. Matches made their appearance soon. Then he thought the ladies wanted something to add to their natural charms, and he launched out into perfume, featuring crushed sandalwood, and two other sorts of wooden twigs. A few days later, although we were miles from anywhere, this amazing boy introduced a kind of red paint for the finger nails, which was closely followed by cigarettes.

Finally an old government blanket of his father's gave a pleasant shade during the heat of the day, and strings of beads were hung up in front of the shop. The whole stock was displayed to greater advantage on a grass mat, which was adorned at each corner by a sugar-loaf, carefully wrapped up in its blue paper.

An Arab merchant from Khartum arrived, and he traded off European cotton cloth for cattle and gum.

THE CHIEF OCCUPATION OF THE NATIVE

The principal occupation of a native man of Darfur is killing time, and his average daily round is as follows:

An early riser, he is up betimes to send his women off, either to the well or to the tebeldi tree to get water. If he owns a fair number of animals, he accompanies the women and assists them. He then sees the animals driven out to pasture by a small boy, who is responsible for bringing them back at night. That finished, his day's work is done.

His wife returns and at once busies herself preparing grain for the thick, fermented beer, like pea soup, which is the principal means of sustenance. She thus

occupies practically her entire day. Meanwhile her lord and master sleeps until sunset, recuperating his strength. If he is feeling very energetic, he perhaps spins a little cotton or weaves some cloth, squatting outside his tukl so that he can keep an eye on his women and see that they do not slack off.

WIVES' WORK CAREFULLY APPORTIONED

As soon as the first rains come, the man goes off with his wife or wives and escorts each to her own patch, because each has her own seed supply, just as each has a separate house.

Holding in both hands a branch of a tree that is bent at nearly a right angle, with sometimes a small iron hoe at the end, he ambles at a jog trot down the cultivated plot. Each time the left foot comes to the ground he gives a jab at the soil at his left side, which displaces the sand a little. When he has gone about fifty paces he turns at right angles, gives a jab, and then turns again and makes a fresh line parallel to the other.

His faithful helpmate walks behind him with the millet seed in a dried watermelon rind, and, without bending, drops a few seeds into the hole, brushes it over with her foot, and passes on to the next. In a day they can plant an extensive area.

As soon as all is planted, he and she wait until the seeds begin to sprout, unless he has planted when the rains are due. This he frequently does in feverish anxiety—the only time he ever exhibits this trait. Then it often happens that there is a dry spell for a month, in which case the grain dies and the work has to be done over again.

THE SURVEY WHEEL USED BY THE AUTHOR IN MAPPING DARFUR

As his province was practically unmapped, wherever Major Keith-Roach traveled he had a native push a cyclometer before him, so that the distance might be accurately noted. Bearings taken with a prismatic compass were also recorded (see text, page 57). Note the baby ostrich in the foreground.

LOCUSTS COME AND WORRY BEGINS

After three weeks of good rain and ample sunshine, the grain comes up, and with it the everlasting haskaneet; so he takes his only other tool, a half-moon-shaped hoe, and hoes the weeds. This is rather harder work, since it entails some back-bending, although the handle is made as long as possible.

HOISTING WATER FROM A DARFUR WELL

The problem of drinking water for man and beast is a serious one in this province, much of which is extremely arid. To supplement wells, the tebeldi trees are sometimes used as storage tanks (see text, pages 64-65, and illustration on opposite page).

After a few more days the crop rises to an appreciable height. Then the one serious worry, fear of locusts, begins. These pests sometimes come in myriads, eating every green thing before them. When they are seen approaching, man, woman, small child, and grandmother hasten to the field and raise a din to try to prevent them from settling. The crop will suffer if each locust takes only one bite, as it sometimes takes an hour or two for a flight to cross the fields.

At the end of four months, if the crop has safely passed through these vicissitudes, the millet is ripe, grown to a height of six feet. The head, some ten inches long, is snipped off and taken to a hard piece of ground near by, where the grain is beaten out by hand. The grain then is winnowed by being thrown in the air, after which it is stored in small pits dug in the ground, to be removed as required.

The long stalks of the millet are used for making tukls, and the remainder, left standing in the fields, is burned later.

A few industrious natives have a source

A TEBELDI TREE, USED AS A WATER RESERVOIR IN SOME PARTS OF DARFUR

When the inside is scooped out, without killing the tree, a tank of from 500 to 1,000 gallons' capacity is available (see text, page 65). The native in the branches of the tree to the right has his leg stretched across the water hole.

of wealth in gum trees, and are able to make a considerable sum of money from the sale of their product as gum arabic. The bushy evergreen trees, with spiky branches, grow wild over nearly the whole of Eastern Darfur.

Tapping the gum starts at the end of October and continues for about five months. Four or five men go out together and tap each other's "gardens" in turn. Armed with a small homemade ax, they beat the bark of the tree a few times to loosen it, then make a cut, and tear the strip upward for a foot or so. If this is carefully done and the incision is not too deep, the stripping removes only the outer bark with a little of the reddish fiber beneath, and does not expose the white wood. If the white wood is uncovered it is liable to attack by white ants and does not heal up properly the next rainy season.

The trees are then left for about 15 days, by the end of which time all the "gardens" have been attended to, and men come back and collect the gum that has

MELONS ARE EXTENSIVELY CULTIVATED IN DARFUR

When the crop has matured the fruit is stored under low-thatched shanties. The pulp is eaten by the natives, and in the dry season quenches thirst (see text, page 65), the pounded rind is fed to live stock, and the seeds are made into a salve for skin diseases.

oozed out at the bottom of the barked portion. Other parts of the trunk are then dealt with until the tree has exhausted itself.

The collected gum is taken to the village and buried in the ground until an opportunity occurs to take it to market, which may be a hundred miles away.

PRIMITIVE TEXTILE MAKING

The cotton crop is very poor; the pod is mostly seed, with the minimum of cotton.

It is ginned between rough rollers, cleaned by being twanged on the string of a bow, and spun by rolling a spindle on the inside part of the thigh.

Little attempt is made to obtain even thickness of the yarn, which is transferred to a bobbin for work in a primitive loom. The warp is formed of about 160 twines, 20 feet long. The shuttle is worked with speed, and an old and experienced man can weave a tobe of twenty feet in two days.

The width of the cloth is one *diraa*—about the length of the forearm plus the width of the hand. It is not made wider because that would require a little more exertion for the man by making him stretch his arms. As it is so narrow, two sides have to be stitched together to make a garment. I suggested to an old man that it would be better if he made a tobe of two diraas' width, and he treated the idea as if it were the best joke he had heard for many a year.

From the finished cotton the men fashion some sort of a rough shirt and trousers, but the women just wrap it around themselves and it serves as skirt and bodice.

TREES ARE WATER WELLS

Throughout Eastern Darfur there are few wells and no permanent water supply; therefore the natives rely entirely on the rains of July, August, and September. On an average, 15 to 20 inches may be expected during this period. The problem of storage for the remaining nine months is solved in a most interesting manner.

Dotted here and there, sometimes in tens, fifties, or even hundreds, there are

THE BEGINNING OF THE RAINY SEASON IN DARFUR

trees formed of a soft, spongy wood with a naturally hollow heart. The outside bark is soft and knobby and is covered with a gum that oozes out of the trunk. They are of very slow growth, and from their size must be of enormous age. They grow fairly straight, sometimes 20 or 25 feet high, before branching off into large boughs.

Many of these trees are of great girth, and two I walked around measured twenty paces. The natural hollow is scooped out and enlarged, leaving a foot's thickness of wood on the outside and some three or more at the bottom. Thus, because of their huge girth, their storage capacity is considerable. Into these living reservoirs the people, using primitive leather buckets, pour the rain water collected from hollows among the roots. The contents of the trees vary between 500 and 1,000 gallons.

In the hot weather the water gets unpleasantly warm, but remains sweet. Toward the end of the dry season, just before the rains break, it is naturally very scarce, and travelers are often asked twenty piasters ($1) for three gallons.

In areas where there are no tebeldi trees and reservoirs are unobtainable, the resources of Nature are not exhausted.

Batikhs, or watermelons, do not grow wild, but are sown in large areas of cleared ground. When the fruits are ripe they are stored away under low-thatched shanties.

Toward sunset the ever-patient donkey is driven down to the field, and enough melons brought back for the next day's use.

MELON YIELDS FOOD, DRINK, FORAGE, AND MEDICINE

A woman brings an earthen vessel with perforated bottom from the smoke-begrimed tukl and squats beside it. Taking a melon, she breaks it with her clenched fist, and, with a hand that is far from clean, scoops out the inside, throwing the rind into the sand again. When all the pulp has been extracted it is teased and squeezed to break up the fiber. The vessel is placed on another and the liquid percolates through straws at the bottom.

The rind is then broken up and pounded in a vessel fashioned out of a tree trunk. All possible moisture is withdrawn and

A YOUNG WOMAN OF DARFUR

the residue becomes food and drink for donkey, goat, and fowl.

Once, when touring to complete my map, I lived for six weeks, using these melons for my sole water supply, and beyond being unable to shave, suffered little ill-effect; but for sheer nastiness, I commend you to tea made from strained watermelon juice.

In a country where everything is of value, time excepted, it is to be expected that some use would be found for the seeds of the watermelon, but expectancy could hardly have predicted the particular manner in which they are employed. In some countries they are dried and strung together and form the principal item of dress of the native. In Darfur, however, they have a far more precious, if utilitarian, value. They take the place of coal tar, sulphur, and all the various prescriptions devised to combat skin diseases.

After the moisture has been drawn off from them, they are lightly dried and a mixture called *gutran* is made. A hole is dug in the ground and a tortoise shell placed in it. A clay vessel is filled with the seeds, wood ash, with dung placed on top, and suspended over the shell. The whole is then covered with a fire. The moisture from the seeds drips through holes at the bottom of the vessel, and after a couple of hours there is a pint or so of thick, black, soupy substance in the tortoise shell.

An animal suffering from skin disease is rubbed over with the mixture, and after a few applications the old hair falls off, showing the skin clean beneath.

Mixed with wood ash, it is also used for curing skins.

STRICT CONVENTIONS FOR DYING

One morning I was requested by the omda to go and see a man who *ous yemoot*—wants to die. I picked up my thermometer and medicines and set off for the tukl. Upon my arrival I found it crowded with people, old and young, relatives and total strangers, all gathered together to help the sufferer pass away.

The man, lying on the sand in the tukl, was *in extremis* and there was little hope. He had been attacked by one of those rapid fevers that come with such dramatic swiftness and call the strong almost before one is aware that they are ill.

Within a minute or two of my arrival the man was nearing his end. As soon as the watchers observed this they quickly pushed him over on his right side, one holding him in that position while another pulled his hands down in front of him to the full extent of his arms. His wife, who was squatting beside him on the right, placed his chin in her left hand,

PLAYING "HOUSE" IN DARFUR

The author describes this photograph as "probably unique, as it shows the only children I ever saw in the Sudan really playing." Their mud houses, of course, follow the customary lines of the tukl (native hut).

forcing his mouth to close, while her thumb and forefinger were placed over his eyes, closing them. Her right hand patted his left shoulder, while she shook with convulsive sobs.

Any chance that one had of administering a stimulant was therefore defeated, as for at least five minutes before death he was kept in this position, so that he might die in the conventional way. There was a struggle for breath, but the hand never relaxed its hold on the mouth. I turned away in horror and as I passed from the hut all was over.

During the whole of this procedure the man's aged mother kept crying out: "Allah el akbar. El hamd el Allah." (God the greatest. Praise be to God.)

He died at 10 a. m. and I was invited to the funeral, which took place at 4 p. m.

MUST FACE MECCA IN GRAVE

I rode out to join the funeral procession, which set off at a dogtrot, while the wife kept pouring forth a lament in a sad, haunting strain that awakened all one's sympathy.

On arrival at the graveside the importance of the man's dying on his right side was at once evident. A trench had been dug, three feet wide and two feet deep. Then, in the middle of this, a second long, narrow trench one foot wide and a foot and a half deep was dug, widened at one end for the feet.

The *Kadi* arrived. He repeated "God is the greatest" five times, and then the body was lowered into the deeper trench, resting on its right side, with the face looking toward Mecca. Short pieces of wood that had been cut from the adjoining bushes were placed across the narrow trench in the middle of the larger one. Splinters of wood were put in the cracks.

Water brought in goatskins was poured on sand by the side of the grave, and this was mixed into mud, which was plastered over the wood. Then all the mourners gathered around and, squatting on their heels, shoveled on sand with their hands. Some bushes were brought, an enclosure of thorns was made around the grave, and then the mourners silently went their several ways.

A COMELY FUROWIAH

The women of Darfur do the hard labor, while the men devote most of their days to resting.

There is much sameness about visits of ceremony. The following is typical of many. The headman of the village received me with great ceremony outside his tukl, conducted me inside, and put me to sit on his native bed, the only thing to sit upon in the dwelling. A large watermelon was produced from under the bed, and from this he cut me an enormous slice, then sat at my feet, watching every mouthful.

A mysterious but heated argument which had been going on for some time outside ceased, and the man's two bearded sons brought in the meal—big flat cakes made of millet flour, a mess of eggs and sour milk beaten together, and a pot of beautifully cooked chickens. The chickens the father pulled to pieces with his hands and presented to me on a small grass mat.

This course was followed by excellent coffee, served in little cups without handles. I had three cups, thinking the meal finished, but an ancient teapot was brought forth, and I capped my repast with a cup of strong, bitter tea, sweetened to a nauseating degree.

A DISCONCERTING FAREWELL

The omda and I talked of many things, and after inspecting his water supply, live stock, and fields, I turned to leave. His two sons were mounted, ready to see me on my way. The old man signed to me to stop. Then the two younger men cantered off some distance, turned suddenly around and, thrashing their horses with their *kurbags* (rhinoceros hide whips), dashed straight at me at a full gallop, pulling their foaming horses back on their haunches about six inches from me. The nearer the visitor, the greater the compliment.

Their bits are very severe and cruel. A curb squeezes the underpart of the jaw and a great port on the bit springs up and hits the roof of the mouth when slight pressure is put on the rein. When galloping the natives appear to be going very fast, but half the time the horse is prancing in the air in fear of the bit's being applied. Any small pony properly bitted and lying on his bit could give them lengths in one or two furlongs.

Nothing is new under the sun and, if one only looks far enough back, it is not difficult to find a precedent for any case that comes up.

MOSAIC LAW APPLIED TO MOSLEMS

Picture a scorching day in the height of the hot weather, and half a dozen natives all talking at once in my office, the crescendo voice of an old woman rising above the others. As soon as they were exhausted by their shouts, which I assure the reader took time, I gathered that the bull of Ahmed had had a fight at the village well a couple of nights before with the favorite bull of Mohamed, and had knocked it down the well, where it died of a broken neck.

Mohamed was lowered at once down the well, slit the throat of the beast in accordance with the tenets of his religion, drew it to the surface, and sold it for butcher's meat for about the equivalent of five dollars. He now claimed the difference between the living animal and the sale price of the dead beast. Ahmed admitted that the fight took place, but contended that his beast had been attacked first, and therefore no compensation was due. Vociferous witnesses, including the shrill-voiced woman, stated that it was a case of "fifty-fifty."

When it was nearing 3 o'clock, after I had been hard at it from 8 o'clock in the morning, I cleared the court and said that judgment would be given next morning.

Literature is a great stand-by to officials living alone in the desert places of the world. During the World War, when often there were no mails from home for ten to twelve weeks at a time, reading matter was hard to come by, and one became a student of the Bible.

That night after dinner, as I lazily turned over the pages of the Bible, I by chance turned to the twenty-first chapter of Exodus, and the thirty-fifth verse gave me the solution to my problem of the morning. Next day, carrying my Bible, I went to court.

It must here be explained that the Moslems have taken to themselves the majority of the old prophets and hold them in great reverence. As soon as the court assembled I explained to the litigants that a similar case had occurred about 3,400 years ago, and the great *Nebi Mousa* (Prophet Moses) had given a law thereon which I proposed to follow. I

BROTHER AND SISTER OF DARFUR CARRYING A LEATHER BUCKET

Although the inhabitants of Eastern Darfur call themselves Arabs and speak that tongue, they are negroids (see text, page 57).

then read the verse: "And if one man's ox hurts another's, that he die; then they shall sell the live ox, and divide the money of it; and the dead ox also they shall divide."

It was decided that the value of the living ox was about $25; so, as Mohamed had already sold his dead beast for $5, I ordered Ahmed to pay him over $10, and the case would be fairly settled.

This judgment gave great satisfaction to all parties and they went away happy to their village.

BIBLE PROVIDES ANOTHER RULING

Now for an extraordinary sequel.

Months afterward I was out on tour, and as I neared the village of these litigants at nightfall I was met by a gesticulating Ahmed, who shouted that this very morning his ox had been attacked at the well, but, unfortunately, this time he was the sufferer and his ox had been thrown down the well by another's.

THE HEAD OF THE LIONESS SLAIN BY THREE BOYS OF DARFUR

A youthful hunter having been struck down, one of his companions, wrapping his long garment around his arm, thrust it down the lioness' throat, while the third boy, armed with a small hatchet, rained blows upon the animal's head until it fell dead (see text, page 72).

After dinner that night, by the light of a glimmering candle, practically all the inhabitants sat round in the sand while I heard the case. It was proved to my satisfaction that Ahmed's beast was quarrelsome and had fought with several other animals that morning, but had been driven off. In the case under review he was clearly the aggressor, but the fortune of war was against him.

Although I did not know whether this particular case was provided for in the Bible, I said that I would look and see whether the Great Prophet had a law for such a contingency.

I then opened the same chapter of the Book of Exodus, and in the last verse found a suitable judgment, which I proceeded to translate to the assembled people.

"Or if it be known that the ox hath used to push in time past, and his owner hath not kept him in; he shall surely pay ox for ox; and the dead shall be his own."

Under these circumstances, as the pushing ox was in this instance dead, I ordered that no compensation be paid by the owner of the living to Ahmed.

TIMBUKTU, MYSTERIOUS CITY OF THE SAHARA (SEE MAP, PAGE 46)

This ancient city of nomads and Moors was formerly a fabulously rich and powerful commercial metropolis of the Sahara. Standing in the midst of burning, shifting sands and a parched vegetation of gum trees, mimosas, and coarse grass, Timbuktu was founded in 1077 by the Tuareg Berbers, then passed into Moorish hands. Mohammedan fanaticism frightened Christians away from it until 1826. Joffre occupied it for the French in 1893.

Photographs by Agence Economique du Gouvernement Général de l'Afrique Occidentale Française

UNLOADING BARS OF SALT

The most exciting event of the year at Timbuktu is the arrival of the salt caravan (see page 80), when natives come in from miles around to purchase a year's supply of the precious commodity, which is obtained from desert mines 300 miles north of the city.

My decision was greeted with shouts of applause, in which, I am glad to say, Ahmed joined, and the people once more were convinced of the wisdom of their revered Prophet.

WHY VILLAGE BELLES WORE LION MEAT IN THEIR HAIR

The Furowi may have many failings, but lack of courage cannot be counted among them.

One morning an oldish man walked into my office and said that a lion and a lioness were molesting the peace of his village, about 15 miles away. He wished me to come and destroy the beasts. I promised to go the following day, but unfortunately the investigation of a case of murder occupied my attention and I could not go.

The day after, the old man came before me, dangling at the end of a piece of rope what I at first thought was a skin of honey, but a second glance showed it was the head of a lioness. He told a story which I corroborated the same afternoon when I went to the village to dress the wounds of the chief actors.

Three boys of about 15 or 16 years—no Arab knows his exact age, but calculates by the time of some striking incident—went out to their field, each carrying a small throwing spear, and they saw the lion and his mate under a bush. The first lad threw his spear and missed, and the quarry bounded off under another bush. The next boy hurled his spear and also missed. A third spear hurtled through the air from the arm of the youngest lad and struck the lioness in the side. She immediately turned and, with one spring, seized the thrower round the shoulders, threw him to the ground, and began gnawing at his neck.

One of the boys took off the long garment he was wearing, bound it swiftly around his right arm, and, grasping the animal's left ear with his left hand, drove his right arm down her throat. As her teeth closed on his arm, the third Arab picked up his small hatchet and rained blows on the head of the lioness until she fell dead at their feet.

The boys soon recovered from their wounds, and for weeks afterward all the girls of the village wore little pieces of lion meat in their hair as a tribute to the prowess of the young men.

The skin of the lioness now adorns my drawing-room on the Mount of Olives, Jerusalem.

TIMBUKTU, IN THE SANDS OF THE SAHARA

By Captain Cecil D. Priest

MANY people have asked me if Timbuktu is an island; others have said they thought it a myth. The truth is that Timbuktu is a famous old city in French West Africa.

The town is situated about nine miles from the most northerly point of the river Niger. In the rainy season it is reached by a canal from Kabara, the so-called port; in the dry season, when the river is very low, a canoe can go only as far as Koryiamo, from which point a pony carries the traveler across dry marshland and sand-dunes to this mysterious city.

I shall never forget the morning I arrived. Here was my Mecca at last, haunted by dreams of the curious and imaginative the world over. Eagerly I scanned the horizon for a glimpse of what I had longed to see since my earliest childhood.

Nor was I disappointed. From my pony I could see what appeared to be huge buildings in the far distance, enshrouded in a haze; and it was only after passing through a thick wood of thorn trees and scrub that I realized how close the town was, and how the buildings stood out against the blue sky and the yellow sand of the desert.

It was the Governor's Palace that had attracted most attention; but other well-built offices and houses of solid stone added to the view, and I marveled how such edifices could have sprung up in the desert.

My purpose in coming to Timbuktu,

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THE MARKET PLACE OF TIMBUKTU

In this sun-baked, congested, ill-smelling trading center and African news exchange, five guttural languages may be heard at one time in hot dispute over the price of blue amulets, copper-inlaid saddles, rancid butter, semi-decayed fish, and fly-blown meat.

however, was not to study modern desert architecture, but to see the natives in the same types of houses which have been in use for a thousand years.

A MOVING PICTURE OF LIFE IN TIMBUKTU

Early the first morning I went up to the flat roof of the Governor's Palace to see the panorama—an indescribably wonderful sight. It was 8 o'clock, and the sun was not yet too high to make things uncomfortable. It shed a warm glow over all the city, causing shadows, reflections, and the sand to harmonize with the general color scheme of the morning.

The first thing to catch the eye was a mosque, a mud dome some 50 feet high, at the far corner of the city, its isolated position making it conspicuous amid the irregular and curiously shaped house tops.

From this point of vantage could be seen a wonderful moving picture of Arabs, Moors, and Tuaregs wandering along the narrow streets; camels with riders, camels with loads, and donkeys with packs; pedestrians shuffling along with their sandals clattering against their heels; and here and there the red fez cap of a French tirailleur. From the market place rose the shrill voices of women and boys calling out their wares.

It was now getting very warm, and at the invitation of one of the French officers I went to his house near the North Fort. It was a charming place, built of mud in true Arabic style, with doors and windows similar to those in Morocco, and divans and cushions much in evidence.

In the evening came a visit to the market and the famous old mosque. I saw the site of the former slave market, and also the present-day settlement of the freed slaves.

Deep sand lay everywhere and roads or paths do not exist.

At 7 o'clock I dined on the roof of a house in the South Fort. It was one of those still African nights, with a bright moon. The chanting of the Arab dancers could be heard in the distance, and the steady beat of the tom-tom went on all night. The air was cool and fresh, but the night was never quiet, as is usually the case in Africa.

The next day was very different in appearance. A brisk wind had sprung

up during the night, and it was impossible to see half a mile from my veranda, owing to the fine sand, which hung over the desert and city like a mantle of fog. Quantities of it blew into the house.

MOHAMMEDAN HOSPITALITY TO A CHRISTIAN

The principal event of the morning was a visit to the chief Marabout, or priest, to whose home an officer acted as guide.

The Marabout was sitting on a mat outside his house. He was a kindly old man of some 60 Timbuktu seasons, clothed in a long, flowing white gown and a turban. His face was intelligent, and as soon as he found I spoke Arabic he beamed with delight, a thing these staid old Mohammedan men rarely do.

He took us into his hall, a sort of porch, and offered us tea, a favorite beverage of the natives, who drink it "neat" out of a glass. As a rule, the tea is as dark as stout in color and made very sweet with sugar. We politely refused a glass, but smoked a good cigarette which his boy brought us. He himself did not smoke, however.

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HEADDRESS OF A NATIVE OF TIMBUKTU

The beads and copper disks are brought by caravan from northern Africa. When traveling in the desert, the native also wears a blue veil, or *litham*, over his nose and mouth. This prevents him from being smothered by the flying clouds of sand and also reduces thirst to a great extent.

Strange to say, I saw little or no coffee used by the natives in French West Africa.

The Marabout told me I was the first Englishman he had ever spoken to and was pleased to meet a friend of the French, of whom he had a very high opinion. He asked what I thought of his native town. When I told him I had often read about Timbuktu, he seemed pleased at the idea of his town being known throughout the world, and started to tell how big it was when he was a boy, and how still bigger it was in his father's time.

To-day Timbuktu has scarcely more than 8,000 inhabitants, and many of these are nomads who pass through with cattle or engage in the great salt trade from the Central Sahara.

Knowing how cordially all Mohammedans hate the Christians and how they dislike being seen talking to them, we said "au revoir" when the conversation began to flag. We also gave the usual hand shake, which consists of holding the

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A STREET IN TIMBUKTU

Life in Timbuktu passes like a slow moving picture through the narrow, tortuous windings of its sand-carpeted thoroughfares. Arabs and Moors in flowing garments, French tirailleurs with gay red fezzes, Fulanis and Tuaregs with sandals clattering at their heels mingle in noisy and picturesque confusion.

man's hand perfectly still for several seconds.

The market place was now becoming congested and the strange-smelling atmosphere was annoying. Meat, covered with flies innumerable, and all sorts of articles of food were being sold. Four or five languages were distinguishable at times, the guttural sounds of the Tuareg being predominant. The noon sun was blazing hot, but a sun-umbrella afforded some relief.

The natives sat on mats, under the shelter of little grass shanties. All sorts of trades were represented: butcher, saddler, leather-worker, grocer, jeweler, perfumer, barber, blacksmith, tailor, and last, but not least, the fishmonger.

There is a big trade in dried fish caught in the Niger, and, since the native is very fond of fish, it is readily understood how a "sun-dried-fish merchant" soon sells out.

I bought some pretty blue amulets and necklaces as curios, and was pestered by an ex-soldier who spoke a little French to buy some of his cigarettes. I did, but soon after I lit one I discovered my error!

In the market place are three European commercial houses where the ordinary necessaries of life can be bought at exorbitant prices. I remember asking the price of a bottle of white wine and was told 55 francs!

After leaving the market place we came to a large hollow in the ground that was for many years the home of an old hippopotamus which had become tame and had lived there much as a pig wallows about a farmyard.

ALL WOMEN SEEN IN STREETS BELONG TO SERVANT CLASS

The streets, or rather passages, were full of people, either going to or returning from the market, which is a sort of African news exchange. The "Anglais" seemed to be an absorbing topic of conversation and curiosity. Arab boys and girls ran past one like fleet little gazelles, while men in passing saluted by raising the hand; the women either turned and ran or passed in a very bashful manner.

Photograph by Agence Economique du Gouvernement Général de l'Afrique Occidentale Française

THE CORNER OF A COURTYARD IN TIMBUKTU

Native houses in Timbuktu are somber-hued, two-story affairs of Moorish design. They are built of sun-dried bricks made of the clay found under the sandy wastes of the surrounding desert. They are usually cool and comfortable, except when high winds befog the air with sand particles and drive sand through windows and doorways into every nook and crevice of house and courtyard. There is an outer and inner courtyard—one for the men, the other for the women.

These women, of course, were only the servants of the wealthy Arabs and Moors; the rich native woman never leaves her house from one year's end to another, unless to travel with her man. She is then veiled completely, and it is difficult to tell whether a male or female is perched on the top of a camel.

The Tuareg women and girls do most of the household work for the richer and more educated natives. The girls are most attractive in appearance, but very dirty. They never wash, as their home is usually in the heart of the desert, where the limited supply of water is reserved for drinking purposes and is kept in the water-bags, slung on the backs of camels and oxen.

The Tuareg is of a light coffee hue, while Arabs are often far lighter in color

© Cecil D. Priest

A TUAREG WOMAN SIFTING FLOUR

The Tuaregs are warlike nomad Berbers, who roam the desert with their sheep and goats. From time to time they visit Timbuktu to barter an animal for some rice, millet, or wheat. All menial work is done by negro slaves, called beylas. Tuaregs live in encampments, in tents made

Photograph by Gouvernement Général de l'Afrique Occidentale Française

A MUSICAL NATIVE OF TIMBUKTU

After a glass of strong tea, this Moor has settled down with his unusual instrument to mingle its queer notes with the monotonous chants of the Arabs and the beating of the tom-toms. He can produce a variety of sounds by working a tiny bow over one string of camel's hair. The mud wall back of him furnishes some protection from the persistent whirls

than a sunburned European. Their eyes, which are very beautiful, belie their jealous and deceitful natures.

Beggars are to be found in all African towns, but I never saw a more pitiable collection than those in "Tombouctou" (as the native calls it). Some were blind, some were cripples, others old and feeble; but all chanted some song or prayer in a monotone, beseeching Allah and the passer-by to give them alms.

As a rule, the native is kind to beggars, but cruel to his animals; donkeys and camels receive rough handling. The usual cure for sore back or girth gall is a green leaf, with a little sand rubbed in.

Little remains of the house of Barth, the great African explorer of the last century. Looking at the ruins, I marveled at the manner in which this famous man must have existed while compelled to stay in the city, long before the French conquered West Africa.

How many changes have been wrought in Timbuktu during the 30 years since Marshal Joffre, then a commandant, made his brilliant march to this city to the relief of the ambushed Bonnier column!

During the rains Timbuktu has a large paddle-boat of some 200 tons; six tall masts of the wireless station can be seen from the city housetops, and the hum of airplane engines coming up from Dakar has been heard.

The telephone and telegraph are likewise in use, the latter being employed by the merchants.

Before the advent of the French, money was little known, barter and exchange serving for all transactions. Cowrie shells are even now used in the market, for silver is scarce and paper money is reluctantly accepted.

HOW THE TWENTY EUROPEANS OF TIMBUKTU AMUSE THEMSELVES

The European population of Timbuktu now numbers about twenty, chiefly government officials, with three or four merchants. A European baby was born in Timbuktu in 1920—the first one in the history of this old town.

Social life is essential in a desert place like this, and the French do all they can to make themselves happy and comfortable. There is a good hospital and a fine, hard tennis court. Riding and shooting, with tennis, constitute the only forms of exercise. Polo has not found its way there yet, but will sooner or later, I think. That is a game in which natives in many parts of the world soon become expert.

A TIMBUKTU SAND-STORM

The wind, which made things so uncomfortable in the morning of my first day, became much worse toward sunset, developing finally into a veritable sandstorm.

The city was enveloped in sand. Natives hurried to and fro, with their flowing garments tucked over their heads to keep the sand out; animals turned their tails to the storm, and everybody waited for one of the ten annual showers of rain.

After an hour's extreme discomfort, the rain came, accompanied by vivid flashes of lightning and terrific crashes of thunder. Then, as if by magic, the sand ceased to blow. It greedily absorbed the moisture, and in 20 minutes we were outdoors, inhaling the fragrance of the picturesque little garden in front of the Governor's Palace.

This little garden was most astonishing. Here in the desert was a miniature Kew Gardens, beautifully designed and laid out, and full of the most wonderful exotic plants, trees, and shrubs.

It was quite a labor to make that garden. All the earth was carried up from the Niger banks in panniers on donkeys, and every day, at sunset, the plants were watered by prisoners, who seemed most interested in their task, although they thought the European idiotic to water flowers or trees—Allah would do that when He pleased.

During the evening, while sitting on the veranda with several French officers, my attention was attracted by what appeared to be an exceedingly bright star, near the horizon.

"That," said an officer, "has a curious history. It is a lamp on the top of the Palais de Justice and is lit every evening at sunset by the police.

"Some years ago we had an energetic police officer here, and he wished to have the town lighted at night by oil lamps, partly to help strangers find their way and partly to help the police recognize

Photograph by Agence Economique du Gouvernement Général de l'Afrique Occidentale Française

A YOUNG GIRAFFE AND ITS CAPTOR

A giraffe family rarely has more than one baby. They feed on mimosa leaves during the day and come down at night to the Niger River to drink. Their curious mottled coat blends perfectly with the sandy background of their desert home. The natives slaughter thousands annually and make the skins into purses and sandals.

strangers who might be wanted for theft or murder. In due time the lamps came from France, but, to his great disappointment, there were only four!

"Naturally, so few were useless for the purpose originally intended, and so a new use had to be devised. Three eventually found their way into various government buildings, and the fourth you see before you, on the top of the Palais de Justice. On a clear night it can be seen for miles and miles out on the desert. It serves as a guide to all men who are late returning, or who are lost at night outside the city."

During this conversation boys had brought a rare collection of syrups, bitter and sweet drinks, and cigarettes, the latter being in an uncommon box made from a block of salt. It was rather the color of rock salt, but clear as crystal and very heavy. These boxes would realize a fortune in Europe, but they never get so far, as they break and crumble in a moist atmosphere.

The Arabs sell the boxes for a mere song, usually bringing them to the city when the great salt caravan arrives annually from the heart of the desert, some 300 miles north of Timbuktu.

YEARLY VISIT OF SALT CARAVAN CHIEF EVENT IN TIMBUKTU

The French Government protects the salt caravan by sending out 200 camel corps men with Europeans in charge.

This strong escort defends this wonderful caravan from the ever-threatening attacks of the marauding Tuaregs and desert tribes.

When the caravan enters Timbuktu a great welcome is given the travelers, and the whole town is *en fête* for several days. The big chiefs from the surrounding districts pay their homage to the commander, and thousands of natives come in to buy their annual supply of salt.

The coming of the caravan is a marvelous sight—some 800 camels laden with salt and hundreds of others ridden by gorgeously robed chiefs, with their various

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SUMMONING A FISHING PARTY AT KABARA, ON THE NIGER, THE PORT OF TIMBUKTU

"Goin' fishin'" is not a sport, but an important industry, in the mud village of Kabara. The drum is a hollow log covered with a taut goatskin. It is used all over Africa to call meetings or to send messages to other towns, its sound being audible for many miles.

bodyguards, either mounted or on foot. The caravan returns north with rice and grain, brought up by canoe from the large agricultural districts of Gundam, El-Waleji, and Gao.

MOSQUITOES A RARITY IN TIMBUKTU

Another day dawns, with a cloudless sky and a cooler feeling in the air, owing to the rain of yesterday, but to last only for a few hours. At noon the fierce sun has made one forget that there ever was a rainfall; the sand has become as dry as a bone, and millions of flies torment man and beast until sunset. Then, in many parts of Africa, the mosquito appears.

Not so in Timbuktu, however. Here this winged pest is a rarity and, if seen, it is given, by way of a joke, a name, such as "Henri" or "Jacques"!

Owing to the scarcity of mosquitoes, there is little or no malaria in Timbuktu, and Europeans can stay there three or four years, enjoying far better health, in many cases, than if they were in France or England. Several residents of the city told me they never found it necessary to take quinine.

Natives suffer a good deal from pneumonia—not so much in the cold season, from December to February, but later on in the year, when the rains come and the weather is treacherous. They are usually so poor that they cannot afford blankets and wood is scarce and expensive. So they simply have to sleep in their rain-soaked clothes.

NATIVE CANOES SKILLFULLY CONSTRUCTED

For exercise, one morning I borrowed a pony for a ride. At the appointed hour a lovely white Arab was awaiting me, with a Fulani boy as groom.

We rode off to the south in the direction of Kabara. It was a pretty ride, but heavy going in the deep sand.

At this little village I was shown around the "harbor," and became interested in the number of native canoes and dug-outs which were being prepared for the time when the river would rise. This event makes little Kabara famous for six months in the year.

Some of the canoes were 50 feet long, skillfully made from two trees. The bulk of the wood of one trunk is chipped

DYE PITS AT JEGA, DISTRICT OF SOKOTO, NORTHERN NIGERIA

Dye pits are found in many towns of northern Nigeria. Both cloths and skins are dipped into circular vats sunk into the ground, and after being dried are beaten over a log. Skins are colored deep red or orange with native dyes. Roots, leaves, and barks are used in the various processes through which the raw hide passes. The finished skin is often very beautiful and as soft as Russian leather.

Photographs © Cecil D. Priest

A CARAVAN RESTING AT MIDDAY

Timbuktu has been called "the meeting place of the camel and the canoe." For centuries it has been the focus of the caravan trade in West-Central Africa. From the north, dusty camels lurch across the Sahara, laden with salt, hardware, beads, sugar, dates, leather, and cheap fabrics. From the south the canoes bring cereals, gold, wax, ostrich feathers, ivory, gums, and rubber.

away, leaving a shell which when shaped is joined to the other tree by strong ropes.

Other boats were fashioned out of rudely cut planks, either laced together with cord or kept in place by iron fasteners. Each canoe had a shelter in the center (see page 85).

The boats are operated by four or five men with long bamboo poles, who stand in the bow or stern, as occasion requires. Sails on these craft are dangerous and are not often used.

The fishing season was in full swing, owing to the low stage of the river, and quantities of nets were drying, while the air was heavy with the odor of fish. Small areas were netted and the results were extraordinary—very often 1,500 to 2,000 pounds of fish were caught at one haul.

A detachment of the Senegalese regiment is stationed here. The guard turned out at the approach of their captain and saluted in a thoroughly soldierly way. Some had medals and many were veterans of the critical struggle at Verdun.

On our way back we passed many flocks of sheep and herds of goats which were being driven down to the river to drink. The poor animals were so lean and underfed that it was a wonder how they crawled along. But thirst and the shrill bark of the cattle boy's "pie-dog" urged them on in spite of tormenting flies.

© Cecil D. Priest

A MOOR OF TIMBUKTU

The great trading class of northern Nigeria is composed primarily of Moors. They are reputed to be both wily and clever.

ATTRACTIVE HOUSES MADE OF MUD

I had luncheon with the post physician in his delightfully cool house made of mud. He had had it painted inside with a wash of "Burem earth," a kind of natural distemper found in the bed of the river Niger at Burem.

In the rooms and halls were many trophies of the chase, the best being a magnificent white oryx head with antlers of remarkable size. There was also a huge crocodile skin some 20 feet in length, and the sun-bleached skull of a hippo reposed outside his front door.

All curtains were of native cloth, with pretty designs embroidered by the tailor-man at the hem. Cushions of leather, neatly carved by the leather-worker, were on chairs and divans, and in some cases they were interlaced with colored strips of the same material, making an oriental pattern.

This leather-work is really lovely and is quite a fine art among the Tuaregs.

SPEARS AND SHIELDS CLEVERLY ORNAMENTED

The native takes great pains with his "hold-all," his substitute for the European box or suitcase. It is very elaborate and often from three to six months are spent in completing it. Fringes of lace hang down for about 18 inches at each end and the opening is laced up like a pair of boots. The nomad's clothes,

SLAIN HIPPOPOTAMUS BEING DRAGGED TO SHORE BY 22 NATIVES

A hippopotamus is generally inoffensive when undisturbed, but capable of surprising bursts of speed and ferocity when aroused. A quick and powerful swimmer, this animal will charge a canoe, overturn it, and crunch it in its powerful jaws. Here and there among the rushes of the Niger are hippopotamus pools, where the unwieldy "river horses" come singly or in herds to feed and bathe.

Photographs © Cecil D. Priest

A LUSCIOUS STRIP OF HIPPO HIDE

The skin of the hippopotamus is very tough and sometimes two inches thick. The natives boil it for food, but a patient application of the fletcherizing process is always necessary. Hippopotamus teeth are highly prized as ornaments, being harder than ivory and less liable to turn yellow.

© Cecil D. Priest

A NATIVE CANOE ON THE NIGER

Nigerians are expert in making canoes out of hollow logs and pieces of dum palm. The larger canoes are fastened together with palm leaf rope or wooden pegs. Their owners ply for miles up and down the Niger, trading in dried fish and cereals. A grass awning shelters them from the blistering sun.

food, and household goods are all jumbled together inside.

On the walls of the physician's house were heavy iron spears, five or six feet long, with beaten brass and copper inlay.

The mounted Tuareg usually bears one of these spears and a shield made of ox hide and nicely carved. More elaborate shields are made from oryx or giraffe hide. These are most serviceable and will resist with ease a sword cut or arrow.

Another article of local manufacture which attracted my attention was a bit, a cruel device consisting of a sharp piece of iron projecting from the bar and designed to be placed under the horse's tongue.

With this bit and spurs, the native is able to make his horse "tripple," regarded by them as the essence of good breeding in a pony. He can also draw the animal up on its haunches from a full gallop within a space of 20 feet—very pretty to watch, but distressing when one realizes the cruelty practiced to accomplish the feat (see also text, page 69).

After luncheon I tasted a new and most refreshing drink called citronelle, a kind of tea made from a grass which the French cultivate in their gardens.

Other wonderful things are also grown along the banks of the Niger at these French posts. I saw melons, strawberries, pineapples, bananas, limes, egg-fruit, pomegranates, and vegetables of every kind.

When the time came for my departure, I rode one cool evening to Koryiamo by moonlight, with an escort of four mounted soldiers. Even in these days it is not safe for Europeans to wander about the desert alone, for the "Razuls," or bandits, will still kill or capture if they get the chance.

INDEX FOR JULY-DECEMBER, 1923, VOLUME READY

Index for Volume XLIV (July-December, 1923) of the National Geographic Magazine will be mailed to members upon request.

Photograph from Andre Citroen

A MEHARIST AND HIS CAMEL LOOK WITH AWE UPON THE NEW SHIP OF THE DESERT

The meharist is an efficient Arab police-soldier of the desert. His mount, the mehara, is a camel especially selected for its speed and is not used in ordinary desert transport. Note the rollers and the bands of canvas and rubber supplying greater traction surface for the motor cars (see text, page 87).

THE CONQUEST OF THE SAHARA BY THE AUTOMOBILE

THE camel no longer holds his own on Sahara sands. Five man-made, mechanical contraptions have defeated him on his own grounds, by reducing to a paltry 20 days the three months' time he usually requires for a 2,000-mile trip across the desert.

The Citroen caterpillar tractor expedition across the Sahara from southern Algeria to Timbuktu and the Niger, in December, 1922, and January, 1923, not only added a worthy page to the history of French exploration in Africa, but also gave impetus to the long-cherished desire of the French to effect a political and commercial liaison between the northern and western colonies of their vast African empire (see map, page 46).

Since the political entry of the French into North Africa at Algiers, in 1830, their control has been gradually extended farther into the desert by the establishment of posts in the principal oases. The central plateau region, however, has been difficult to manage, and the success of the Citroen expedition is regarded as an important step in opening up this key region to the great desert and in the control of its important north-to-south caravan routes.

A railway will doubtless come to cross the Sahara in due time. Meanwhile its quick and trusty advance courier, the automobile, goes before to discover more of the secrets of the mighty unexplored spaces of the mysterious desert.

There is much that we think we know, but more that we do *not* know about the Great Sahara Desert. There is, to be sure, sand a-plenty in the northern stretch and toward Egypt to the east, but there is a vast region of varied surface and irregular relief, containing rocky plateaus, tracts of loose stones and pebbles, mountain ranges, gorges, and valleys, about which our information is decidedly nebulous. In some sections the desert lies 100 feet below sea-level; in others it rises from 5,000 to 8,000 feet.

Rolling, shifting sand dunes constitute only one-ninth or one-tenth of the Sahara's entire area. South of Algeria they give way to a rugged, rocky region, which is displaced in its turn by vast plateaus of massive black rocks, boulders, and pebbles. Beyond, 900 miles from the coast, lie the lofty crags of the Hoggar Plateau, with peaks 8,000 feet or more in height.

ROLLERS AND CANVAS BELTS SUPPLANTED WHEELS

The Citroen caterpillar tractors were especially designed, after many tests, to operate successfully over this varied and difficult terrain. They had to conquer slipping, clogging sands and sharp, piercing stones.

The most interesting feature of their construction was in the rear, where wheels gave way to rollers. These were covered with a continuous band of rubber and canvas, which made a tough and supple rail on which the car could travel. This increased the traction surface and also obviated the danger of the car's sinking into the sand (see page 86).

Before the start from southern Algeria, two auxiliary parties were sent out, one from Tuggurt and one from Timbuktu, to establish oil and supply depots within some 625 miles from each point.

In spite of sand-drifts, boulders, gullies, waterless stretches, a sandstorm, broiling suns by day and icy temperatures by night, the expedition averaged 100 miles a day.

Tuggurt, the sand-locked terminus of the South Algerian Railway in southern Algeria, was the starting point for the adventure. The convoy covered the first 125 miles of its itinerary, across the sands to Wargla, without difficulty. From this famous date-growing region it followed the big, dried-up waterway of the Wadi Mia Valley, amid dunes, to Fort Hassi Inifel, some 250 miles farther south. This small station is lost in the sandy masses of the Great Eastern Erg (erg meaning sand hill), which stretches almost uninterruptedly from Morocco on the west to Tripoli on the east.

After Inifel the aspect of the desert begins to change from sandy plains, with stretches of bluish and gilded dunes, to a desolate, gloomy country strewn with

IN THE SAND-DRIFTS NEAR INIFEL, ALGERIA

The area of the entire Sahara has been estimated as more than 3,400,000 square miles—almost as large as all of Europe. The desolate sand dunes along the northern edge, 100 miles from the Mediterranean coast, and the fanatical nomads of the interior long prevented fuller knowledge of the peoples and places of the center of the great desert.

Photographs from André Citroen

THE CITROEN TRANS-SAHARA EXPEDITION MAKING CAMP NEAR A DESERT WELL

Each of the five Citroen tractors was constructed somewhat differently from the others, for practical demonstration purposes. Two were equipped with rapid-fire guns, in case of attack by Tuareg nomads, and the other three carried searchlights.

THE TRACTORS MAKING THEIR WAY THROUGH A SEA OF SAND

The personnel of the Trans-Sahara Expedition consisted of the manager of the Citroen automobile works, a former military airman, a representative of the French Air Ministry, a scientific observer, a moving-picture operator, and five expert mechanics. The longest single stage of the journey between supply stations was 812 miles.

Photographs from André Citroen

IN THE VALLEY OF THE WADI MIA

This deep-cut river bed descends from the Tademait plateau, and its dried-up stream was once one of the most important of this region. Though the Sahara has lost many of its former surface rivers, French engineers have irrigated large areas by tapping artesian waters.

Photograph by Lehnert and Landrock

A BEDOUIN CAMP OF NORTHERN AFRICA

Probably no desert tribe arouses more interest in the western mind than do the Bedouins. From time immemorial they have lived in their black camel-hair tents in the desert, sometimes robbing caravans, sometimes trading in articles of their own manufacture, and occasionally nowadays condescending to a little agriculture.

Photograph by Lehnert and Landrock

CHILDREN COLLECTING DATES IN AN OASIS OF THE SAHARA

In many parts of the Sahara French engineers have sunk artesian wells, with the result that former waste places have been made to flourish with palms.

Photograph from André Citroen

A STRETCH OF THE DUNE REGION

The Sahara dunes are subject to continual change, under the influence of the winds; but, taken as a whole, their topography is permanent. They range in height, in various parts of the desert, from 60 to 300 feet.

sharp rocks and cut by deep crevasses. This is the plateau of Tademait, characterized by the remarkable black tint (or "desert varnish") of its rocks.

The next 280 miles, through the sinister Ain El Gettara Pass and across the vast plain of Tidikelt, were strenuous going. The ground was covered with boulders, difficult to clear, and a sharp lookout had to be maintained against marauders at the same time. Tidikelt is a region of mirages.

ENTHUSIASTIC WELCOME AT HISTORIC IN-SALAH

At In-Salah, the succeeding station, the convoy was met by the entire population, waving palm branches and escorted by a camel corps and Arab horsemen firing salutes. This oasis is the last one in North Africa and a center for caravans from the French Sudan, the Hoggar, and the Air.

After leaving In-Salah the tractors continued over rocky ground, passing many carcasses of camels overcome by the sun and the desert. The Christmas camp was made in the blue mountains of Muydir, on the edge of the Hoggar country, the real center of the Sahara.

Then the convoy entered the Hoggar through a mountain pass, and beyond it lay perhaps the most perilous part of the journey—the almost waterless, treacherous Tanesruft, a region of sandstorms, boulders, and rocky valleys.

New Year's was spent at a well on the borderland between North Africa and French West Africa. Then another stop at Kidal, a small post in the southern Adrar (mountain) of the Iforas, and on through the Saharan region of the Sudan itself to Burem and the Niger. Here, for the first time in history, the true liaison between French colonies in northern and western Africa became a reality on January 4.

The remaining stretch along the Niger west to Timbuktu (see pages 72-86) was easily made in 27 hours without a stop.

As the convoy swung into the sand-blown streets of the ancient capital amid the cheers of the natives, a new chapter in the history of scientific exploration was concluded and civilization approached a bit nearer to the heart of Africa's most mysterious domain.

Photograph by Lehnert and Landrock

THE METHOD OF CROSSING THE DESERT WHICH MAY BE SUPERSEDED BY MOTOR TRANSPORTATION

Great care is exercised in selecting beasts of burden for a caravan trip across the Sahara. At towns in the desert, Sahara camels, accustomed to the great wastes of sand, are obtainable. The animals which live near the coast have become more or less accustomed to drinking at frequent intervals and require water every two or three days. Those of the Sahara can go much longer without water.

THE SOUTHEASTERN CORNER OF REELFOOT LAKE, SHOWING THE GREAT LILY-PAD CIRCLES IN THE FOREGROUND

The dark spots in the middle of the airplane picture are submerged cypress trees. Grassy Island and Willow Point extend out into the lake in the background.

REELFOOT—AN EARTHQUAKE LAKE

By Wilbur A. Nelson

With Illustrations from Official Photographs, U. S. Army Air Service, Taken by Captain A. W. Stevens and Lieutenant George W. Polk, Engineering Division

REELFOOT, an earthquake lake of Tennessee, was born about the time that the first venturesome pioneers began to settle along the banks of the mighty Mississippi.

Perhaps De Soto, in his wanderings along the Mississippi River, saw this country as a vast unbroken wilderness. As he thrust wearily northward along the west bank of the "Father of Waters," to the great Indian village of Cahokia, he little dreamed that this placid wilderness would within three hundred years be torn and racked by Nature's forces, and that during one of the greatest earthquakes of historical time lakes covering tens of thousands of acres would come into existence over night.

The old Spanish settlement of New Madrid, formed many years after De Soto had come and gone, did, however, play a prominent part in recording the story of Reelfoot, for here resided many of our American pioneers whose letters supply the details of that, to them, awful winter.

THE LEGEND OF REELFOOT LAKE

At the beginning of the 19th century this region was called Indian Country, and rightly so, for in the rich bottom lands dwelt a tribe of the Chickasaws, which camped at the base of bluffs that rose 300 feet above the Mississippi, providing the lookout points so needed in a wilderness.

Legend says that at the time of our story a mighty chief ruled wisely, yet his heart was heavy, for his only son had been born with a deformed foot. As the boy grew up he developed normally, but his walk was different from all other Indians. He walked and ran with a rolling motion; so his people called him Kalopin, meaning Reelfoot.

When the old chief died, Reelfoot became chief. He, too, was sad and lonely, for as yet none of the Indian maidens had stirred in him the thoughts of love.

His father had often recorded to him tales of the mighty tribes dwelling to the south, and of the wondrous beauty of their maidens. So, restless in spirit, when the robins arrived from the north, seeking a mating ground, he likewise gathered a few of his chosen tribesmen—Osceola, Nashola, and Biwier—and wandered south in quest of a princess.

THE DREAM PRINCESS IS FOUND

Many days they journeyed. Finally their canoes, floating down the river, entered a domain having different tribal customs, and there were signs which told them that they were approaching the abode of a mighty chieftain.

Reelfoot sent runners forward to notify the great Choctaw chief, Copiah, that a friendly party approached. Soon the chief's councilor came forward to welcome the strangers to the council fire.

When the village was reached Reelfoot went forward to offer the requisite homage to Copiah, and then, continues the legend, he beheld his dream princess, more beautiful than he had ever dared imagine, sitting close by the side of the chief, her father.

The old chief was stately and dignified, as all Indians are on such occasions, and after they had smoked the great peace pipe and eaten of the freshly killed game, he inquired of young Reelfoot the reason for his visit.

Reelfoot replied that he was on a pilgrimage to find a princess to rule his tribe with him, and that now he saw his heart's desire for the first time.

At this the old chief was filled with wrath, for he knew the beauty and entrancing charm of his only daughter, and what chief would want his daughter to marry one deformed, even though he be powerful!

So old Copiah told Reelfoot that his daughter was only to be given in wedlock to a Choctaw chieftain, and under no circumstances could she join a tribe which

THE NORTHEAST CORNER OF REELFOOT LAKE AROUND WALNUT LOG

Walnut Log Hotel is situated in the clearing in the foreground, on the left bank of the lake. The light-colored area to the north of the water is shallow water, covered with lily-pad growth; the dark-colored water in the middle foreground is deeper water, free from lily pads, and the dark specks are dead cypress trees. This part of the lake is famous for its ducks. The Mississippi River is the light portion in the upper right corner, and the southern end of Reelfoot Lake is in the background to the left.

REFLECTED SUNLIGHT ON LILY PADS AND SEED MOSS IN REELFOOT LAKE PRODUCES THE EFFECT OF SNOW

This effect is produced only in a photograph, as it does not suggest snow in reality. Note the parallel lines of trees growing on the low crests, indicating the rhythmic motion of the earth at the time of the quake (see text, page 106).

AËRIAL VIEW OF THE NORTHEASTERN CORNER OF REELFOOT LAKE, SHOWING THE SUBMERGED CHANNEL OF BAYOU DE CHIEN

The channel shows up clearly in this airplane view, as the water is much deeper than the shallow lake water, and the lily pads only grow in shallow water, up to the banks of this old submerged channel. To the left of the Bayou de Chien are masses of cypress trees growing in water five feet deep (see also illustration, page 105).

HICKMAN, KENTUCKY, JUST NORTH OF REELFOOT LAKE

The town lies a few miles north of the Tennessee line and is located on a 300-foot bluff at the edge of the Mississippi River. The white strips which look like reflections, on the right bank of the river, are submerged sand banks.

was so unfortunate as to have a club-footed chieftain.

This made Reelfoot sick at heart, but he was more firmly resolved than ever to have this one Indian maiden. So he offered her father pearls and skins and other treasures which would arouse envy even in the greatest chieftain's heart. Then the old chief sent for the tribe's medicine man, who called publicly on the Great Spirit.

The Great Spirit spoke to Reelfoot, saying that an Indian must not steal his wife from any neighboring tribe, for such was tribal law; and if he disobeyed and carried off the princess that He, the Great Spirit, would cause the earth to rock and the waters to swallow up his village and bury his people in a watery grave.

Reelfoot was frightened at this threat of dire punishment, and stifling his longings deep in his heart, sorrowfully turned his canoes toward the North Star and home.

Summer had come when the home country was reached, but to Reelfoot it

HILL LANDS OF THE REELFOOT LAKE SECTION IN THE FOREGROUND

Reelfoot Lake is in the center of the picture, the Mississippi River in the central background. The double bend of the river occurs along the line between Missouri and Kentucky, part of each bend being in each State. This view was taken looking toward the west. The cleared areas in the immediate foreground are farms; the dark areas are wooded lands.

AËRIAL VIEW OF REELFOOT LAKE AND TIPTONVILLE, LAKE COUNTY, TENNESSEE, FROM AN ALTITUDE OF 3,000 FEET

On the banks of the Mississippi River, looking eastward, with Reelfoot Lake in the background.

A COMBINATION REFRIGERATOR, BATHTUB, AND DRINKING FOUNTAIN

This spring proved a joy to the aviators who made the photographs illustrating the Reelfoot Lake region. Here it is being used for drinking purposes.

THE SAME SPRING AS A SWIMMING POOL

The flow is sufficiently abundant to provide an entire change of water in thirty minutes. The aviators also found it an excellent place in which to keep provisions cool.

lacked one thing—Laughing Eyes, forbidden to him by the Great Spirit. Through the long summer days the Indians fished and hunted, and Reelfoot as chief was doing his part in storing up food for the coming winter.

But his activities did not keep Reelfoot from thinking of his love and wondering if the Great Spirit would really do as he said.

AND THE EARTH TREMBLED

For the first time Reelfoot did not want to believe the Great Spirit; so, as the days grew short and the maize was gathered, he planned with his warriors to go south and capture the forbidden maiden. When the first snows came they started, and, swooping down on the Choctaws, he captured the princess and fled back to the north.

Laughing Eyes was greatly frightened, for she had heard what the Great Spirit had said to Reelfoot. She feared for herself and implored that he send her back to her father; but Reelfoot was in love and, now that he possessed his longed-for bride, was willing to defy everything.

One starry night he brought his princess bride home, and there was great rejoicing among his people, for now their tribal family was complete. The festival fires burned; the pots boiled and the venison browned on the spit.

In the midst of the festival and the marriage rites the earth began to roll in rhythm with kettledrums and tom-toms.

The Indians tried to flee to the hills, but the rocking earth made them reel and stagger. Chief Reelfoot and his bride reeled also and the Great Spirit stamped his foot in anger. The Father of Waters heard and, backing on his course, rushed over Reelfoot's country.

Where the Great Spirit stamped the earth the Mississippi formed a beautiful lake, in the bottom of which lay Reelfoot, his bride and his people.

Such is the Indian legend of Reelfoot Lake.

THE ACCOUNT OF AN EYEWITNESS

Here is the account of the earthquake as given by one of the pioneers, Eliza Bryan, living at New Madrid, near the cliffs where Hickman now stands (page 99). She wrote to her pastor, the Reverend Lorenzo Dow, the following letter:

"DEAR SIR:

"On the 16th of December, 1811, about 2 o'clock a. m., a violent shock of earthquake, accompanied by a very awful noise, resembling loud but distant thunder, but hoarse and vibrating, followed by complete saturation of the atmosphere with sulphurous vapor, causing total darkness. The screams of the inhabitants, the cries of the fowls and beasts of every species, the falling trees, and the roaring of the Mississippi, the current of which was retrograde for a few minutes, owing, as it is supposed, to an eruption in its bed, formed a scene truly horrible.

"From that time until about sunrise a number of lighter shocks occurred, at which time one more violent than the first took place with the same accompaniments.

"There were several shocks in a day, but lighter than those mentioned, until the 23rd of January, 1812, when one occurred as violent as the severest of the former ones, accompanied by the same phenomena.

"From this time on until the 4th of February the earth was in continual agitation, visibly waving as a gentle sea. On that day there was another shock, nearly as hard as the preceding ones; next day four such, and on the 7th, at about 4 o'clock a. m., a concussion took place so much more violent than those preceding it that it is denominated the 'hard shock.'

"The Mississippi first seemed to recede from its banks, and its waters gathered up like a mountain, leaving for a moment many boats, which were on their way to New Orleans, on the bare sand, in which time the poor sailors made their escape from them.

"Then, rising 15 or 20 feet perpendicularly and expanding, as it were, at the same time, the banks overflowed with a retrograde current rapid as a torrent. The boats, which before had been left on the sand, were now torn from their moorings and suddenly driven up a little creek, at the mouth of which they had laid, to a distance in some instances of nearly a quarter of a mile.

"The river, falling immediately as rapidly as it had risen, receded within its banks with such violence that it took with it whole groves of young cottonwood trees which had hedged its borders. They were broken off with such regularity in some instances that persons who had not witnessed the fact could be with difficulty persuaded that it had not been the work of man. The river was literally covered with wrecks of boats.

"The surface of the earth was from time to time by these hard shocks covered to various depths by sand which issued from fissures that were made in great numbers all over this country. Some of these closed up immediately, after they had vomited forth their sand and water. In some places, however, a substance resembling coal or impure stone coal was thrown up with the sand.

"It is impossible to say what the depth of the

AN AIRPLANE VIEW OF REELFOOT LAKE, LOOKING TOWARD THE EASTERN BANK AT SAMSBURG

All of the trees in the foreground are growing in lake water. Reflection of the sunlight on the seed moss and the lily pads growing over the lake causes the white areas. Nick's Toehead is in the right background and the buried channel of Bayou de Chien to the left of it.

fissures was; we have reason to believe that some of them were very deep.

"The site of this town was settled down at least 15 feet, but not more than a half mile below town there does not appear to be any alteration of the bank of the river.

"Back from the river large ponds, or lakes, which covered a large part of the country, were nearly dried up. The beds of some of them are elevated several feet above the former banks, producing an alteration from their original state of 10 or 20 feet, and lately it has been discovered that a lake was formed on the opposite side of the Mississippi, in the Indian country, upwards of 100 miles long and from one to six miles wide, of a depth of from 10 to 50 feet.

"We continue to feel light shocks occasionally. It is seldom that we are more than a week without feeling one, and sometimes there are three or four in a day. There were two this winter past, much harder than for two years past; but since then they appear to be lighter than they have ever been.

"Your humble servant,

"ELIZA BRYAN."

Several such letters are full of interesting detail, yet now we know that the

CYPRESS TREES GROWING IN WATER COVERED WITH A CARPET OF SEED MOSS

facts were greatly exaggerated. For example, the 100-mile lake is nearer 14 miles in length and 4½ miles in width.

This we do know and realize, however: that such an earthquake, if occurring at the present time, would probably cause ten times the damage which followed the San Francisco earthquake of 1906.

MANY OTHER LAKES FORMED

Reelfoot was not the only lake formed, for large areas in eastern Arkansas and northwestern Louisiana were partly submerged and a number of small lakes formed. This earthquake, known historically as the New Madrid earthquake, caused a settling and rising of the land over a large territory, and partly demolished the old Spanish settlement from which it was named.

Although the region affected was a wilderness, it was a wilderness which had lured many travelers, and during that winter of 1811-12 the frontier settlements of the Mississippi were visited by Audubon, John Bradbury, a noted English botanist, and Major Long, with his expedition, on the way to the Rocky Mountains.

In middle Tennessee lived Andrew Jackson, practicing law in the primitive courts during periods of quietude between his expeditions against Indian foes. Davy Crockett lived near by and was getting his training, which ended so tragically in the Alamo.

Most of these noted men left accounts of what happened.

General Rogers, of Revolutionary fame, living at Rock Island, on the Caney Fork River, at the foot of Cumberland Mountains, 200 miles to the east, saw great blocks of sandstone, loosened from the top escarpment, 1,000 feet above the river, crash down the mountain sides.

A great area throughout America was affected by this earthquake. Far up in the northern woods of Canada the Indians reported that earth tremors occurred; to the west, in Missouri and Arkansas, the reports of James's expedition say that the Indians were terrified by the same quake, while to the southwest, on the Washita River, there was much fear among the settlers. At New Orleans, 500 miles away; at Detroit, 600 miles away; at Washington, 700 miles away, and even at Boston, at a distance of 1,100 miles, slight tremors were felt.

What occurred in the Reelfoot region? What happened to New Madrid? There were no hard rocks in that section; all the country was covered by rich loams and

SECOND GROWTH OF CYPRESS TREES IN REELFOOT LAKE

clays, and under this surface soil was layer after layer of loose sand and clay, down to a depth of 2,000 feet.

The earth waves came up through these 2,000 feet of sand and clays, and where breaks occurred on the surface poured streams of quicksand from deeply buried layers, veritable sand geysers.

The great forest trees moved, with branches interlocked, like fields of grain before the wind. Their trunks, not having the suppleness of youth, fell prostrate or reclined at grotesque angles to the earth.

MOTION OF EARTH SHOWN BY TREES

The rhythmic motion of the earth is well shown by the parallel lines of cypress trees growing on the low crests of the many rolls in the Reelfoot Lake region (see illustration, page 97.) An airplane view brings to life again the roll of the earth as it occurred more than a century ago.

New Madrid, laid out by the Spaniards on the banks of the Mississippi, was near the center of this earth movement, and it fared badly; for here the bluffs settled and the sand geysers spouted out of crevices, which, according to eyewitnesses, were 100 feet deep. The river banks caved in and most of the old town was absorbed into the Mississippi.

The happenings are vividly described in a letter by one eyewitness, who recounts the experiences of a riverboat captain:

"We immediately cut his cable, and he put off into the middle of the river, where he soon found the current changed. The boat hurried up, for about a minute, with the velocity of the swiftest horse, and he was obliged to hold his hand to his head to keep his hat on. On the current running its natural course, which it did gradually, he proceeded down the river, and at about daylight came to a most terrific fall, which, he thinks, was at least six feet perpendicular, extending across the river and about half a mile wide.

"The whirls and ripplings of this rapid were such that his vessel was altogether unmanageable and destruction seemed inevitable; some of the ripples, he thinks, were at least 30 feet deep and seemed to be formed by the water's being violently sucked into some chasm in the river's bottom.

"He and his men were constantly employed in pumping and bailing, by which,

ALONG THE SOUTHERN BANK OF REELFOOT LAKE, NEAR THE SPILLWAY

and the aid of Providence, he says he got safe through. As soon as he was able to look around he observed whole forests on each bank fall prostrate, to use his own comparison, like soldiers grounding their arms at the word of command.

"On his arrival at New Madrid he found that place a complete wreck, sunk about 12 feet below its level, and entirely deserted; its inhabitants, with those of the adjacent country who had fled there for refuge, were encamped in its neighborhood. He represents their cries as truly distressing.

"A large barge, loaded with 500 barrels of flour and other articles, was split from end to end and turned upside down at the bank. Of nearly 30 loaded boats, only this and one more escaped destruction. The water ran 12 feet perpendicular and threw many of them a great many rods on shore; several lives were lost among the boatmen."

Just to the south was Caruthersville, which, according to all accounts, could justly be called the Sodom of the United States, for the entire town was destroyed. The inhabitants were more fortunate, however, than the ancient people, in that they found safety in the hills and forests.

A graphic description of this community has been left by Timothy Flint:

"They had their settlement, which consisted of 100 families and which was located in a wide and very deep and fertile bottom, broken up.. When I passed it and stopped to contemplate the traces of the catastrophe which remained after seven years, the crevices where the earth had burst were sufficiently manifest, and the whole region was covered with sand to a depth of two or three feet.

"The surface was red with oxided pyrites of iron, and the sand blows, as they were called, were abundantly mixed with this kind of earth and with pieces of pit coal. But two families remained of the whole settlement. . . . When I resided there, this district, formerly so level, rich, and beautiful, had the most melancholy of all aspects of decay, the tokens of former cultivation and habitancy, which were now mementos of desolation and destruction.

"Large and beautiful orchards left uninclosed, houses uninhabited, deep chasms in the earth obvious at frequent intervals. Such was the face of the country, although the people had for years become so accustomed to frequent and small

TRAVERSING THE DEAD CYPRESS STUMPS OF REELFOOT LAKE

shocks, which did no essential injury, that the lands were gradually rising again in value, and New Madrid was slowly rebuilding with frail buildings adapted to the apprehensions of the people."

During the last 100 years the Mississippi River has continued to ravage the areas along its course during the flood seasons, and as New Madrid was partly submerged, due to the 1811-12 earthquake, so was Tiptonville in 1878, when it came in the path of this mighty current, at this point cutting away its eastern bank.

Day after day the river tore away its bluff bank, eating gradually up to the town; and then one who was there saw the spectacle of a moving town, for as the river cut into the settlement the houses were moved out and over to the far edge of the community. Thus a considerable portion of the town was gradually subjugated to the devouring power of the river in 1880. Now, content with what it has done, it is gradually moving away again to the west, leaving the town far from its former channel (see page 101).

While the Mississippi writhed back and forth across its mighty plain, the newly born Reelfoot Lake grew more beautiful, and Nature began to heal scars on the landscape which were inflicted at its birth. Its clear, brownish water became the home of many fish and its surface was dotted with lily pads, called "yoncopins," whose gorgeous flowers had the imprisoned yellow of a river sunset. In and around the stunted cypress growths, struggling for existence in five feet of water, was a filmlike iridescent green carpet, called "moss seed." Along the borders of the lake a dense growth of saw grass, mulefoot, smartweed, and even wild rice soon appeared.

A LAND OF DELIGHT FOR THE NATURALIST

To this haven of beauty, teeming with plant growth and fish, soon came, on their yearly 20,000-mile pilgrimage, the wild denizens of the air—ducks, geese, water turkey or cormorants, coots, and the white heron, while the rail, gallinule, bittern, and teal nested among the saw grass and the lily pads.

As wild fowl and wood folk flocked in, so did the French trapper and the American hunter and pioneer. Here one still finds the mink, weasel, and otter,

A CATCH OF REELFOOT LAKE FISH AT SAMSBURG

along with our friends the opossum and raccoon.

As the country was gradually developed, a number of the sport-loving settled along the lake and lived on fish from its waters and the fowls from its marshes, while the trapping of animals supplied their necessary revenue.

Located in the most-used highway of migratory birds, Reelfoot Lake is visited in the spring and autumn by no small percentage of our journeying waterfowl. From a naturalist's standpoint, the region is one of great interest, for here is to be found the Austroriparian fauna, a name designated by scientists to indicate those forms of plant and animal life which inhabit the warm region of the Gulf Coast and up the bottoms of the Mississippi River to its junction with the Ohio.

Here, too, one finds the pecan tree in all its productiveness, the bald cypress, and typical southern swamp timber, draped and festooned with wild grape and rattan vines, while on such land as has been cleared cotton is the staple crop.

The Purple Gallinule, Mississippi and Swallow-tailed Kites, Little-Blue Heron, Chuck-will's-Widow, Loggerhead Shrike, and Florida Barred Owl mark Reelfoot Lake as their northernmost point of distribution, or nearly so, while in late summer large flocks of the Wood Ibis, locally called Gourdhead, visit the lake after their breeding season is over in Louisiana.

While the season of migration marks the high tide of bird life on the lake, its summer residents are numerous and of great interest. An active ornithologist should be able to list 250 species of birds here during the course of a year.

HAUNT OF EAGLES, HERONS, AND CORMORANTS

Our national bird, the Bald Eagle, still holds its own here, amid the great expanse of forest with which the lake is surrounded, and enjoys a mixed bill of fare, consisting of swamp rabbit, fox squirrel, and fish, frequently securing the latter by robbing the Osprey in mid-air.

At least two pairs of eagles nest here at present, choosing the tops of the largest bald cypress for their huge nests, at a height of 150 feet or more above the

A THIRTY-FOUR POUND CATFISH TAKEN IN REELFOOT LAKE

The waters of this region teem with Bream, Gar, Crappie, and many other varieties of fish, which are caught in quantities for market.

ground. One of these nests is located adjacent to a large nesting colony of Great Blue Herons and Double-crested Cormorants, and it may be surmised that the young of these birds are always on the ample bill of fare spread out for the consumption of the young eaglets.

Two large colonies of the Herons and Cormorants have been located and visited by Mr. A. F. Ganier, of Nashville, who has made a study of the animal life of the lake. In both cases the birds have chosen an isolated portion of the cypress swamp, where several acres of the trees, standing in waist-deep water and inaccessible by boat from the open lake, have insured a relatively safe nesting place.

Each colony was found to contain about 400 nests, perhaps a third of which were those of Cormorants, the nests being placed in the tops of the cypress trees at an average height of 110 feet above the water.

HERONS AND CORMORANTS IN SAME TREE

Several nests of each of the two species are frequently placed in the same tree, the huge platforms of the Herons being placed well out on the branches, while the compact, rounded nests of the Cormorants, are saddled in the crotches formed by the larger limbs at their junction with the bole of the tree.

By the last week in April the nests of the Herons are occupied by hungry and vociferous young, while the Cormorants are just settling down to the task of incubating their four or five chalky-white eggs. Within the last few years a colony of American Egrets nested at the upper end of the lake, but these lovely birds were suddenly "shot out" by plumers, and it is not now known if any of the survivors have been able to reëstablish themselves in the vicinity. A small colony of

Little Blue Herons exists at the south end of the lake, while the ever-present Green Heron completes the roll call for the breeding members of this family.

The ducks which remain to breed are confined to the Hooded Merganser and the beautifully plumaged Wood Duck, both of which nest in hollow trees, usually above the water. The latter species is fairly common here, though nearly extinct elsewhere over its former range.

A few other ducks which are found throughout the summer are crippled individuals, incapacitated during the hunting season, and it is claimed that these occasionally mate and breed.

Reelfoot is not suited for the breeding of ducks, other than the tree-nesting variety, because of the fact that there is little or no shallow marsh in its environs. The immense tracts of saw grass are submerged during the breeding season by several feet of water, while the shallow edges are occupied by growths of trees, willows, and button bushes.

Many marsh-loving birds that would otherwise nest here are discouraged from doing so by the lack of shallow grass-grown water in which to wade. The little Least Bittern, however, is a summer resident in the saw grass and the Coot is said to breed here occasionally also.

One of the most characteristic birds of the lake is the Prothonotary or Golden Swamp Warbler, which nests abundantly all about the lake, in cavities of the ancient cypress stumps. Many a fisherman, tired of his quest of the finny tribe, has laid his pole aside to watch these dainty birds, attired in gold and brown, examine each near-by stump and snag, and perhaps even the prow of his boat, with no show of fear whatever and with a constant ringing song of cheer.

The hunter's season at Reelfoot begins October 15, and old timers flock here during the first big rain, knowing that it will be followed by a cold snap and accompanied by an avalanche of ducks and geese. The Mallards are always most numerous, but the Pintails, Redheads, Black Duck, Teal—in all about 20 varieties—are to be found here. Hunters in the near-by cities are notified by telegraph by their guides when a "flight is on," and a mad influx of Nimrods follows.

The inclinations of the moving ducks cannot be foretold by even the most experienced of the local hunters, and the flight may last a week or only for a day. At times no amount of shooting seems to affect their stay, while at other times a day's bombardment will send them all to the near-by Mississippi River, to the lakes of the St. Francis Basin, some miles to the westward, or perhaps hurry them on in their journey to the swamps and rice fields along the Gulf Coast.

When ducks fail, the hunter turns to the Coot, which at times is present in such numbers as fairly to blacken the surface of the lake. "Acres and acres of Coots" is the word brought back quite frequently by hunters who have filled their bags.

Many years ago Swans were among the most abundant of the migrating waterfowl on this extensive sheet of inland water. As late as 50 years ago they were shipped to Nashville and Memphis in box-car lots, where they were retailed at 25 cents apiece.

The Canada Goose is a regular winter visitor, and nested here in the earlier days. They adapted themselves to local conditions by choosing for their nesting sites the stumps of broken-off cypress trees, and there in comparative safety feathered their nests, after the manner of geese, with down from their own breasts.

THE CORMORANTS CONDUCT FISH DRIVES

During the fall and early spring, immense flocks of Double-crested Cormorants gather on the lake and consume considerable numbers of small fish.

These birds conduct "fish drives" by forming in long, crescent-shaped lines and beating the surface of the water with wings and feet. They cause such pandemonium among the small fish that the latter rise to the top and are easily captured.

When their appetites are satisfied, the birds fly up into the dead cypress trees, where their black bodies line the limbs like carrion crows, or else they betake themselves to high air and soar away to some fresh inlet to repeat the maneuver. Local fishermen call them "nigger geese," and are glad that only comparatively few remain at the lake to breed.

The smaller mammals are as much at home in this primeval habitat as are the

A FULL-BLOWN BLOSSOM OF THE BIG YELLOW YONCOPIN LILY

AN AREA COVERED WITH YONCOPIN LILY PADS

This American equivalent of the Egyptian Lotus is the chief flower of Reelfoot Lake.

A FIELD OF YONCOPIN LILIES

VEGETATION WHICH HAMPERS MOTOR BOATING ON REELFOOT LAKE

Water milfoil (*Myriophyllum*) grows profusely in the northern part of the lake.

birds. In the early-settler days the Elk was an abundant resident of the surrounding country, but has been extinct here for nearly 75 years. During recent years the Black Bear has followed the Elk, and now the Virginia Deer has been almost extirpated.

Some few Beaver and Otter are still to be found in the swamp areas, while the Raccoon, Opossum, Mink, Muskrat, Gray and Flying Squirrels are common.

The king of the lake fish is the Alligator Gar, growing to a length of eight feet, and this species is closely followed by the bulky, though picturesque, Spoonbill Catfish. Other fish in large variety and number are present, including such famous game fish as Crappie and Bass. They swell the population of the waters to such an extent that anglers from far and near make Reelfoot the mecca of an annual pilgrimage.

Snakes are much in evidence in summer. The commonest of the swimming snakes is the Water Moccasin, which glides through the water with surprising swiftness and grace, while along the banks, in some quiet sunlit spot, may be found the thick-bodied and repulsive Stump-tailed Moccasin, which disdains to move its clumsy body aside for the passage of man or beast.

Natives say that this creature possesses some mysterious power which enables it to make its presence felt, and, according to them, "though the hunter's feet and eyes may be following a squirrel among the tree-tops, he is suddenly brought to a rigid halt in time to withdraw the foot which would next have been placed on the back of one of these venomous reptiles."

A PRIMEVAL MONSTER OF THE DISMAL SWAMPS

Most primeval of the lake's aquatic monsters is the Alligator Terrapin, or Loggerhead, which is found in holes or deep places in the swamp. Imagine a creature with moss-covered shell, thick as armor plate, as big as a washtub, and surmounted by horny scales not unlike those of the extinct Glyptodon, with huge feet bearing heavy claws, a head as large as that of a ten-year-old boy, snapping its powerful jaws, hissing and leaping at curious tormentors, and you have a picture of this denizen of the dismal swamps. The mouth consists of a hooked bill, closing over a lower one with such power and force that a stick as large as one's wrist is readily snapped in two.

The reptiles, batrachians, and insect forms have been studied only very briefly and casually, and here lies a rich opportunity for the naturalist and student of science to investigate the animate life of the Reelfoot Lake region, which is as diversified as it is extensive.

THE NIGHT RIDERS' WAR

Some 15 years ago the State of Tennessee, realizing the value of Reelfoot Lake as a source of revenue, made it a fish and game preserve.

The trappers and settlers along the lake considered it free to all, and especially to those who had lived and settled along its borders. They resisted the right of the State, and the night riders' war of 1908 began. It culminated in October of that year, on the banks of the lake, in an attack on Quentin Rankin and Judge R. Z. Taylor, two prominent lawyers representing the landowners of that section. During the attack Rankin was hung on the banks of the lake and Judge Taylor, who was seventy years old, escaped by diving into the Bayou de Chien, and, through a fusillade of shots, swam and crawled through the lake marshes to safety.

The whole country side was implicated, and after the sheriff finished serving warrants there were not enough men left in the lake region to get in the winter supply of firewood.

But once more the Reelfoot region is peaceful. The fish industry is thriving and the sportsmen throng the settlements of Samsburg and Walnut Log during the duck-hunting season.

The inhabitants make their living by fishing, and there is seldom a day when less than 2,000 pounds of fish, mostly the famous Reelfoot Crappie, are not shipped to the markets. During the fish season the daily shipments go as high as 5,000 pounds. Along with the Crappie are found the Gars, the Bream, and the large blue Channel Catfish, often weighing 30 to 50 pounds.

Here, in the heart of the United States, on the east bank of Reelfoot, is one of the few remaining primitive spots in the country.

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THE HAWAIIAN ISLANDS

America's Strongest Outpost of Defense—The Volcanic and Floral Wonderland of the World*

BY GILBERT GROSVENOR, LL. D.

President National Geographic Society

AUTHOR OF "THE LAND OF THE BEST," "PEARY'S POLAR EXPLORATIONS IN THE FAR NORTH," "YOUNG RUSSIA, THE LAND OF UNLIMITED POSSIBILITIES," "THE CAPITOL—WONDER BUILDING OF THE WORLD," ETC., ETC., IN THE NATIONAL GEOGRAPHIC MAGAZINE

THE Hawaiian Islands, the crossroads of the Pacific, are the most isolated inhabited islands in the world, more than 2,000 miles from their nearest neighbor, California. They have been built along a crack on the ocean bottom by a string of volcanoes, some of which have hoisted themselves seven miles straight up from the ocean floor.

On a map of the Pacific Ocean they look no larger than a pin-prick, probably the reason why some of our friends, not members of the National Geographic Society, asked my wife and myself how we could entertain ourselves for eight weeks in such a small place.

The members of this Society know that the Hawaiian Islands are one of the wonderlands of the globe; that Nature conceals in them more of her mysteries to attract and chain the attention of the student and more of her masterpieces to enrapture the visitor than in any similar area.

Here American ingenuity, courage, and energy have wrought seeming miracles, unsurpassed elsewhere, and achieved discoveries beneficial to all mankind.

*An address delivered before the National Geographic Society in Washington, D. C.

When discovered, the Islands were already inhabited by a handsome semicivilized race, a happy and kindly people, fond of music and of the beauties of Nature, but subject to a peculiar and harsh form of religion, of which the *tabu* was the principal feature. There were several days in the month, for instance, when no one could stir abroad, could fish or swim, under penalty of death by the king priests.

The tabu was especially severe to the women, who at no time of the year could eat the choicest foods—bananas, coconuts, turtle, etc. No woman could eat in the presence of a man, or in the house in which he ate, or have her food cooked in his oven. Two ovens and two houses to eat in were, therefore, required by every family.

The irreverent will immediately suggest that if Adam and Eve had been Hawaiians, we would have been saved much trouble.

The Hawaiians were sufficiently removed from the Tropics to be compelled to work for a living, and thus became intellectually and physically more alert and vigorous than the islanders of the South Pacific. Life in the sea, from which much of their food was obtained, developed

Drawn by A. H. Bumstead

MAP SHOWING THE STRATEGIC LOCATION OF THE HAWAIIAN ISLANDS AT THE CROSSROADS OF THE PACIFIC

They command every important trade route to China and the Orient across the Pacific.

superb and agile figures, making them the most daring and powerful swimmers in the world.

They had been living on these islands probably for untold centuries before the advent of Cook, in 1778. They had come in canoes hollowed out of single logs by tools cunningly made of rock and hard lava. They had no metals.

Some of the canoes made on the Islands were 70 feet long and could carry 50 or more men. The giant koa trees from which they were fashioned were cut high up on the mountains, painfully and laboriously, with stone axes, and then, with ropes made of vines, dragged shoreward by hundreds of willing hands.

It is believed the Polynesian race, to which the Hawaiians belong, originated in India. Their voyages across the pathless seas rival those of the Vikings. With no compass to assist them and with only the stars and sun to guide them, they broke through the skyline to journey 2,000, 3,000 miles in their frail but unsinkable craft.

PRIMITIVE PEOPLE MADE CLOTH FROM THE BARK OF A BUSH

From the bark of a small bush they made paper cloth, which they ingeniously colored in many attractive designs, using for dyes juices from berries.

A gift of this lovely tapa cloth was the most highly esteemed present. Cook describes receiving a prodigious number of these valuable pieces of tapa from native chiefs. The cloths were delivered in peculiar fashion. Hundreds of yards, representing years of skillful toil, were wrapped round and round a girl's waist, until she staggered under the weight of this present.

They were governed by kings of giant stature, who were absolute and had power of life and death. These rulers were

Photograph by Henry W. Henshaw

SPEARING TURTLE, HAWAII

believed equal to the gods, and the common people were made to lie on the ground when the king came forth. Color Plate I pictures a king clad in feather robes, with feather helmet and *puttees of sharks' teeth.*

One of these royal feather cloaks now in the Bishop Museum at Honolulu is valued at one million dollars; 100 years were required to make it, as only the feathers of a rare bird, the mamo, could be used. These feathers are almost as delicate and slender as the hair from the human head.

Only a single feather under each wing of the mamo possessed the requisite color, texture, and length for the royal cloak. The birds were caught by a glue spread on trees, and after the two feathers were removed from the captive—one from each wing—it was set at liberty to raise another crop of feathers.

So irregular were marital relations that the Hawaiian language at the time of the arrival of white men contained no word for "father." So even was the climate throughout the year that there was no expression for our word "weather."

When Cook landed, in 1778, he was greeted as the God Lono, who the Hawaiians had been taught by their priests would arrive on a floating island; he was given quarters on a temple at Napoopoo and worshiped as a deity. But his men were overbearing and ruthless, and when they needed wood removed the sacred fences around the temple and even the sacred images.

When one of Cook's men died, the white men were recognized as mortal and the halo that surrounded them vanished. Cook was killed in a fight, his flesh stripped from the bones and fed to dogs,

Photograph by E. A. Wolff

THE VIEW FROM THE NUUANU PALI, ABOVE HONOLULU (SEE PAGE 140)

Through the break in the ridge on the left, which marks the Nuuanu Pali, the northeast trade rushes with such violence day after day throughout the year that often the observer cannot stand against it.

and his heart preserved and hung to the rafters of a hut, where it was found by some boys, mistaken for the heart of a pig, and also eaten.

TABLE MANNERS OF THE EARLY HAWAIIANS

"Their ceremony of eating," writes Albert P. Taylor, in his charming and authoritative narrative, "Under Hawaiian Skies," "was far superior to that prevailing in the baronial halls of Europe, where gluttony and lack of niceties in the partaking of food were in contrast to the delicacy of methods prevailing at the fern-covered tables of the chiefs under Hawaiian skies. Trunks of trees fashioned into bowls beautifully polished, and other bowls of varying sizes and designs, furnished the table.

"There were large, round bowls for poi; long, concave trenches for roasted pig; wide, flat ones for fish; small calabashes and gourds for relishes and desserts; large ones filled with water, with fern leaves floating upon the surface, for use as finger bowls—providing the ancient Hawaiian with dishes that, in a measure, are as beautiful as the chinaware which graces our modern, civilized tables.

"There was no hasty use of both hands over a fish, or fowl, or pig. Reclining upon one elbow, even as epicurean Romans and Greeks of old reclined, the chief used the fingers of the other hand to separate the flesh before him, and each morsel was conveyed to the lips with as much delicacy and grace of movement as possible, and the finger bowls were frequently used. Can we say as much for the Europeans of the Dark Ages?

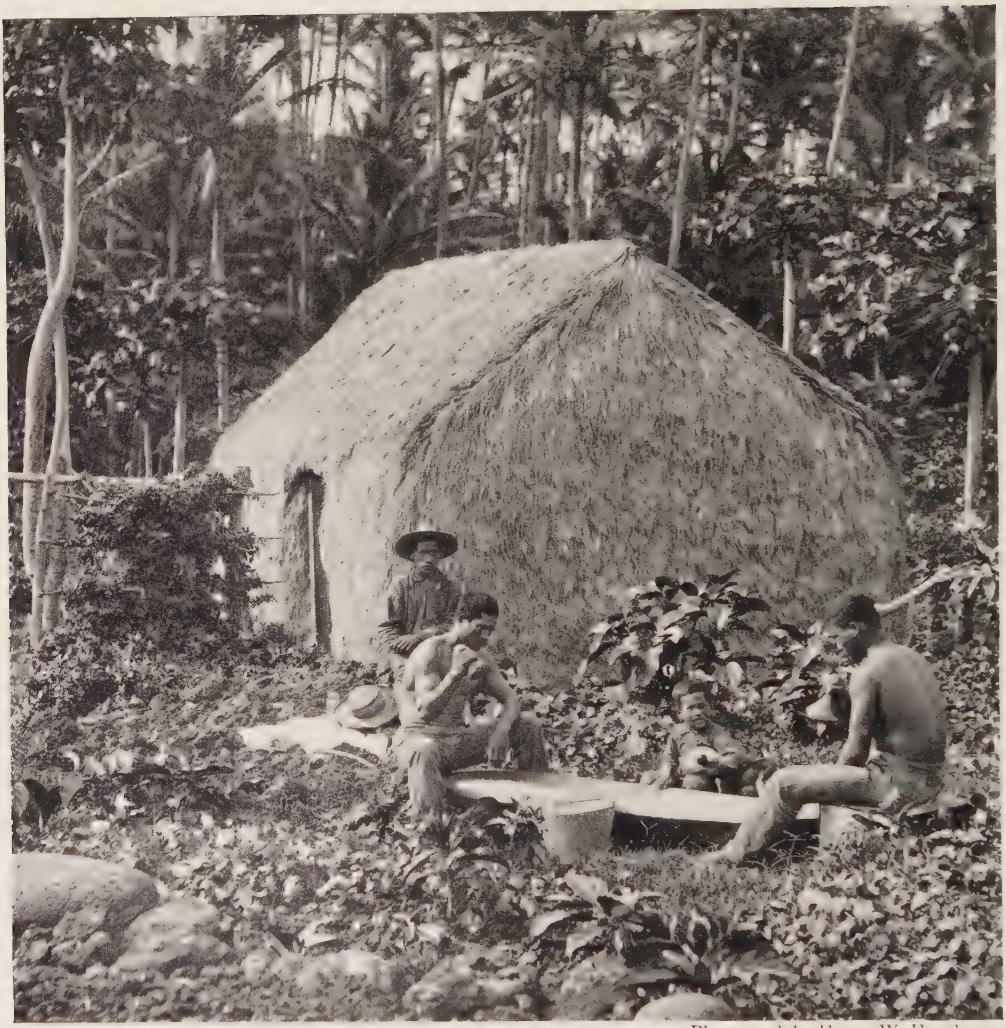
"So closely allied were the ceremonies of the Hawaiian priests to those of the Jews of ancient Palestine—even to the manner of constructing their temples—that there is cause to wonder at such superior civilization.

"*The Hawaiians had their Temples of Refuge, into which the pursued from justice, malefactors, and innocently accused persons, could seek*

Photograph by Henry W. Henshaw

ONE OF THE WORLD'S HIGHEST ISLAND PEAKS, MAUNA KEA, 13,823 FEET, ON THE ISLAND OF HAWAII

The great cones of Hawaii rise from the shore in such long, easy slopes and are of such enormous bulk that their great height is not apparent from the sea.



Photograph by Henry W. Henshaw

AN OLD-TIME GRASS HOUSE IN HAWAII, 1890

The only grass house to be found in the Islands to-day is carefully preserved in the Bishop Museum, and the only hula-hula girls to be seen are those in burlesque shows.

and receive shelter and respite from injury until the temple authorities could determine their guilt or innocence.

"They had their purification of the temples with salt, similar to the ceremony in Palestine. They performed the ceremony of the circumcision as it was performed in the Holy Land. They had their ashes and sackcloth. The priesthood was related to the government and to the direction of the habits of the rulers as the priesthood was related to the rulers in Palestine."

American interest in the Hawaiian Islands really begins with the sailing from Boston of the first small company of missionaries in the fall of 1819.

NEW ENGLAND MISSIONARIES KINDLED AMERICAN INTEREST IN THE ISLANDS

In altruism and religious fervor, that little missionary band which embarked on the *Thaddeus* October 23 resembled the group of the Pilgrim Fathers on the *Mayflower;* the latter were sacrificing all to seek in a distant land religious freedom for themselves, the former were sacrificing everything to take religious liberty and light as they conceived it, to others.

Probably no page in American history

Photograph by Henry W. Henshaw

A CALABASH CARRIER IN ANCIENT HAWAIIAN DRESS IN THE FERN FOREST

The most valuable of their household utensils was the calabash. It was fashioned from wood or made from the shell of the gourd. The Hawaiian people knew nothing of the potter's art. In the carving of these wooden bowls with stone tools much skill was exhibited. Some of them are thirty inches in diameter, and are among the most remarkable objects wrought by the ancient Hawaiians.

is more stirring and romantic than the adventure on which those young men and women of New England embarked. It has been told many, many times; but, like the stories of the Old and New Testament, and of the founders and saviors of our country, it gains in interest and wonder with each new telling.

Some Hawaiian boys had been brought to New England by American whalers. Their stories of the godlessness of their native islands so aroused the sympathy of the churches, which were already in a ferment of enthusiasm for that new "fad," foreign missionary enterprises, that some good people at once organized to send missionaries to Hawaii, then called the Sandwich Islands.

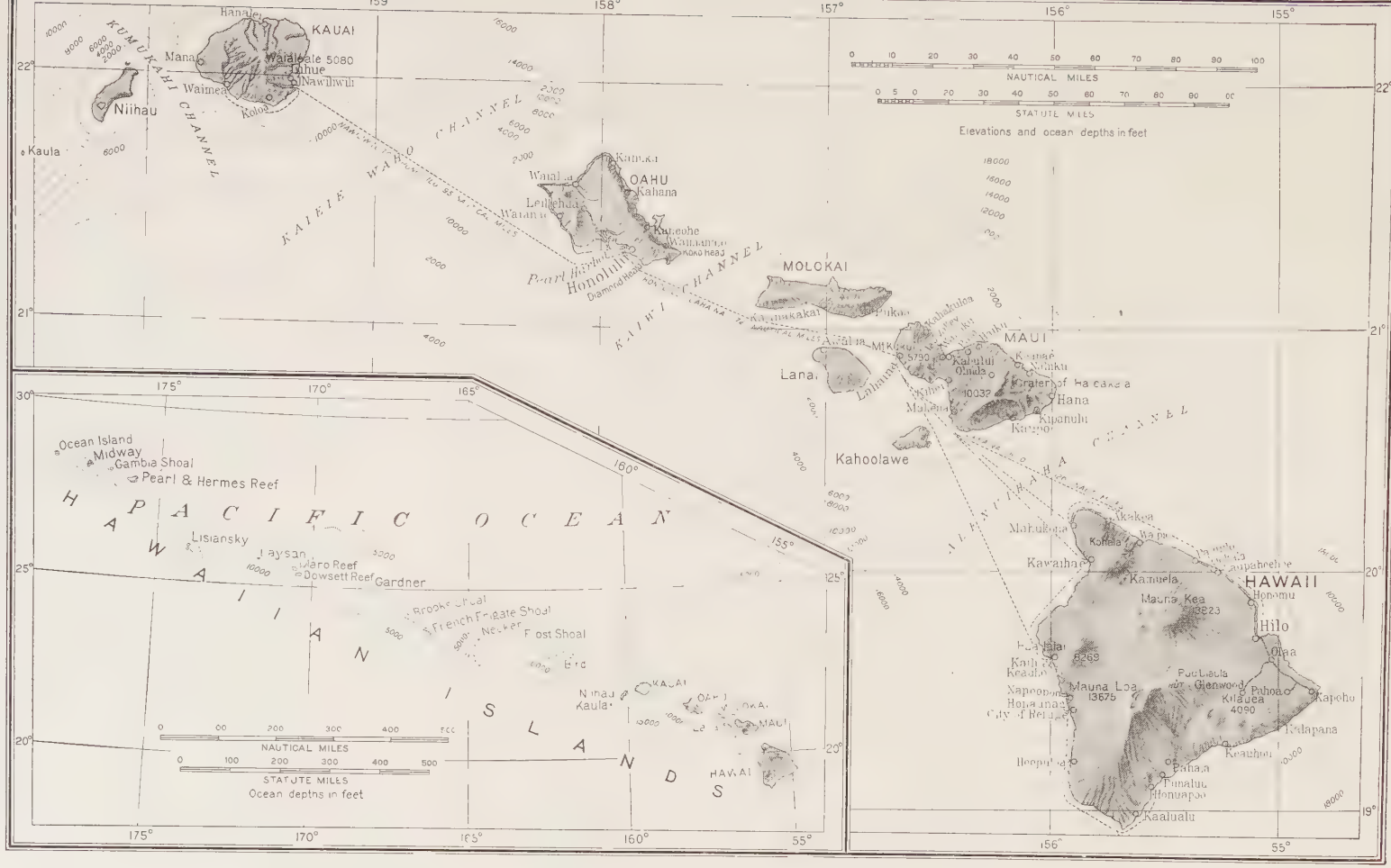
Revival meetings were held throughout the colleges, and volunteers called for. Many offered their services, but only few could be chosen, and these were young

ROYAL FISH POND AT KANEOHE, OAHU

By compulsion of the Hawaiian kings long before the arrival of Cook, the natives, with incredible labor, had built sea walls (see page 146) to enclose arms of the sea, thus making excellent ponds in which to keep and propagate fish for the royal table.

Photographs by R. W. Perkins

ROYAL FISH POND AT HEEIA, OAHU



Drawn by A. H. Bumstead

MAP OF THE HAWAIIAN ISLANDS

The Territory of Hawaii includes innumerable islands, extending from Hawaii on the southeast to Ocean Island, nearly 1,500 miles to the northwest. Large commodious steamers ply regularly between the four principal islands of the group, so that the visitor can move comfortably from island to island, taking his flivver or big limousine with him if he chooses. Oahu, Maui, Kauai, and Hawaii maintain a splendid system of highways. In a remote geological era, the islands from Kauai to Hawaii probably formed one single island. For detailed maps of Oahu, see page 134; Maui, page 145, and Hawaii, page 183.

men picked for their excellence in virtue, industry, intelligence, and education.

Most of these young men were unmarried and must need be provided with wives. So volunteers were called for from among the young women, and they, too, were subjected to rigid tests of their piety and womanly virtues. Among the chosen was Lucy Goodell, teacher, from whose diary I quote:*

"Marlboro (Mass.), West Parish,
"Saturday, Sept. 18.

"Yesterday, during my noontide intermission, I received, at my boarding house, an unexpected call from cousin Wm. Goodell. He gave me information that a mission to the Sandwich Islands was to sail in four or six weeks, dwelt upon it with interest and feeling, and notwithstanding his efforts to assume his usual cheerfulness, now and then I saw the tear start in his eye.

"His conversation and appearance made me tremble.

"At length, having prepared my mind, the proposition was made: 'Will Lucy, by becoming connected with a missionary now an entire stranger, attach herself to this little band of pilgrims and visit the far-distant land of Obookiah?' . . .

"The gentleman proposed as the companion of my life is Mr. Thurston, member of the senior class in Andover Theological Institution. He had recently become an accepted missionary of the American Board of Commissioners for Foreign Missions, soon to sail for the Sandwich Islands. This has all come suddenly upon him. Now that he knows the situation he is called to fill, he has no personal knowledge of one who is both willing and qualified to go with him to a foreign land. . . .

"What could I say? We thoroughly discussed the subject, after which I gave permission for a visit. Next week, on Thursday, is the anticipated, dreaded interview of final decision. Cousin William walked with me and, as we approached the schoolhouse, bade me good-by. I immediately entered the school, but how I longed to find my chamber, that I might give vent to the feeling of an almost bursting heart. Last night I could neither eat nor close my eyes in sleep.

*"Life of Lucy G. Thurston."

"Sept. 21, Tuesday.—The subject has been to my mind utterly overwhelming, and I all alone during this season of conflict. Situated six miles from my father's, I have no confidential friend near me to whom I can unfold my feelings.

"William Goodell fully informed my family that the waters were troubled. During the week my two sisters from home, Eliza and Meliscent, called on and comforted me with their sympathy and affection. I have received, too, communications from my father. But they all leave me to myself, to act agreeably to my own judgment and inclination.

"Dear to my heart are my friends and country! Yet, all this side the grave, how transient! The poor heathen possess immortal natures and are perishing. Who will give them the Bible and tell them of a Savior?

"Great as must be the sacrifices, trials, hardships, and dangers of such an undertaking, I said, 'If God will grant His grace and afford an acceptable opportunity, Lucy and all that is hers shall be given to the noble enterprise of carrying light to the poor benighted countrymen of Obookiah.' After this decision, I could contemplate the subject with a tranquil mind and unmoved feelings.

"Home, Sept. 22, Wednesday.—This afternoon I returned to the paternal abode. I have, with the most perfect freedom, conversed with my family here on the subject. They left me alone to breast the billow. But when I came among them with composure and serenity, buoyed up by a noble purpose, they gave me their full sympathy and approbation.

"Sept. 23, Thursday.—The close of this day brought our expected Andover friends, William Goodell and Mr. Thurston, to our door and established them in our parlor. That was a strictly private family interview. I returned home and alone entered the house the night before. Our dwelling was completely isolated from neighbors, and not a word had been dropped of expected company.

"We were alone in our little world. There were my father and my two brothers and their wives, all belonging to the house. . . .

"The early hours of the evening were devoted to refreshments, to free family

sociality, to singing, and to evening worship. Then one by one the family dispersed, leaving two of similar aspirations, introduced at sunset as strangers, to separate at midnight as interested friends.

"*Sept. 24, Friday.*—In the forenoon, the sun had risen high in the heavens, when it looked down upon two of the children of earth giving themselves wholly to their Heavenly Father, receiving each other from His hand as His good gift, pledging themselves to each other as close companions in the race of life, consecrating themselves and their all to a life work among the heathen."

THE FIRST COMPANY SAILS FOR HAWAII

Four weeks later Lucy Goodell, as the wife of the Rev. Asa Thurston, sailed for Hawaii in the First Company, which included, besides her husband and herself, several other young couples, the Rev. and Mrs. Hiram Bingham, Dr. and Mrs. Holman, Mr. and Mrs. Whitney, Mr. and Mrs. Ruggles, Mr. and Mrs. Loomis, and Mr. and Mrs. Chamberlain and their five little children.

Photograph by Henry W. Henshaw

A PURE-BLOODED HAWAIIAN GIRL WEARING THE COSTUME OF PAST GENERATIONS

The Hawaiian Islands are very near to us now. The printers' ink will hardly dry on these pages before the daylight flight from Honolulu to San Francisco will be achieved, and we are already speculating on how soon the tourist will go from Boston to Hawaii in three days by air transit.

But so distant were the Islands from Boston in 1819 that not until seventeen months after the *Thaddeus* sailed was intelligence received in Massachusetts of the safe arrival of the party at its destination.

The young missioners were agreeably surprised when they landed in Hawaii. They had had no prevision of the equable and healthful climate which they would discover, nor of the pleasant and sympathetic greeting which they would receive from the hospitable natives.

Nor had they been advised that a few months previous to their embarkation from Boston Kamehameha the Great had died, and that his favorite widow had induced the people to shatter the old practices of tabu and idolatry, and had further influenced the new king to eat in company with women for the first time.

The Hawaiians, having discarded their old rites as barbaric, were agreeable and receptive to new teachings. To win their confidence and support, all that was required from the youthful company from Boston was tact and evidences of character and sincerity, all of which they had in abundance.

Photograph by Gilbert Grosvenor

A BIRD'S-NEST FERN

There are forty species of this genus in Hawaii. They are common in the trunks and forks of trees in the forests, and in the cities are much cultivated. Some specimens have leaves 4 feet long and 8 inches wide. Here a small specimen is seen immediately below the larger "nest."

Recalling those days many years later, Mrs. Thurston wrote: "In 1820 the first foreign ladies reached these shores that were ever seen by the eyes of natives. They were seven in number, including one mother with five children. That company had only liberty to come on shore and stay one year. What circumspection, what power of endurance they were called upon to exercise!

FIRST WHITE WOMEN AND CHILDREN WERE RARE CURIOSITY

"The ladies were a rare curiosity to the nation; the children more so. To turn from scenes of pressing their own children beneath the sod with their own heels, or, if allowed to live, to go entirely naked; then to behold our children dressed with shirts, pants and coats, with dresses and neck-attire, with stockings and shoes, with hats and bonnets, they were delighted, they were fascinated with them, as much as our children would be with a fresh importation of London dolls.

"Kalaimoku, a great warrior, who put down the rebellion in favor of idols, who sustained the position of prime minister of the nation, and was called the Iron Cable, passed by educated men and chose little Daniel Chamberlain, five years old, to be his teacher in learning the English alphabet.

"When Mrs. Chamberlain started to go to church with her family, by the time she got there she was as destitute of children as young married ladies. One queen would secure a child, another a second, and so on. (We had ten queens in those days.) . . .

"The winning influence they [the children] exerted over the minds of natives in causing the mission so quickly to become the acknowledged teachers of the nation will never be appreciated in this life."

THE QUEEN ADOPTED NEW ENGLAND STYLES

The queen welcomed the New England costume as passionately as our modern ladies greet the latest styles from London and Paris. Mrs. Thurston, the slim young bride of 23, gives an amusing incident in her diary. The favorite wife of the king desired to borrow a dress from Mrs. Thurston.

Drawn by A. H. Bumstead

MAP SHOWING THE PROBABLE MIGRATION ROUTES OF THE HAWAIIAN ISLANDERS FROM ASIA

If those ancient Polynesian mariners could find the little Hawaiian Islands, which are more than 2,000 miles distant from the nearest starting base, it does not seem unreasonable to credit the supposition that some of them also voyaged occasionally to the American mainland.

"The favorite queen applied to me for one of my dresses to wear on the occasion [of a great feast]; but as it was among the impossibles for her to assume it, the request happily called for neither consent nor denial. She, however, according to court ceremony, so arranged a native-cloth *pau*, a yard wide, with ten folds, as to be enveloped round the middle with seventy thicknesses.

"To array herself in this unwieldy attire, the long cloth was spread out on the ground, when, beginning at one end, she laid her body across it and rolled herself over and over till she had rolled the whole around her.

"Two attendants followed her, one bearing up the end of this cumbrous robe of state and the other waving over her head an elegant nodding flybrush of beautiful plumes, its long handle completely covered with little tortoise-shell rings of various colors.

"Her head was ornamented with a graceful yellow wreath of elegant feathers of great value, from the fact that after a

FATHER DAMIEN

"The man who shut with his own hands the door to his sepulchre."—R. L. Stevenson.

© Pillsbury Picture Company

SUNSHINE ABOVE THE CLOUDS PHOTOGRAPHED FROM THE RESTHOUSE AT THE SUMMIT OF HALEAKALA (10,032 FEET), MAUI

EVERY ACRE OF MOUNT WORTH AIKEN, MAUI, UNDER CULTIVATION OF PINEAPPLES

Photograph by Williams' Studio

A BIRD'S-EYE VIEW OF ONE OF THE GREAT PINEAPPLE PLANTATIONS OF THE HAWAIIAN ISLANDS: PHOTOGRAPH TAKEN FROM THE FAMOUS PALI OF HONOLULU (SEE PAGE 118)

AN EXAMPLE OF THE FERTILITY OF THE SUGAR-CANE LANDS IN THE HAWAIIAN ISLANDS (SEE PAGE 153)

Photograph by Williams' Studio

PINEAPPLE PLANTATION ON THE ISLAND OF OAHU

Long strips of specially treated paper are laid over ground which has been carefully prepared. Through punctures in the paper, slips of pineapple are inserted. The paper, by conserving the moisture and subduing the weeds, increases the growth of the plant and the yield of fruit and also greatly reduces the labor of cultivation (see page 175).

THE EXPERTS OF THE EXPERIMENT STATION MAINTAINED AT HONOLULU BY THE HAWAIIAN SUGAR PLANTERS, THE WORLD'S FOREMOST RESEARCH INSTITUTION IN THE TROPICS AND SUBTROPICS (SEE PAGE 149)

mountain bird had been caught in a snare, but just two small feathers of rare beauty, one under each wing, could be obtained from it. A mountain vine, with green leaves, small and lustrous, was the only drapery which went to deck and cover her neck and the upper part of her person.

"Thus this noble daughter of Nature, at least six feet tall and of comely bulk in proportion, presented herself before the king and the nation, greatly to their admiration. After this presentation was over, Her Majesty lay down again upon the ground and unrolled the cloth by reversing the process of clothing."

NOTABLE FIGURES IN THE HISTORY OF MISSIONARY ACTIVITY

One might as well try to understand the United States without the story of the *Mayflower* as to endeavor to appreciate Hawaii without the story of the *Thaddeus* and the other little ships which carried to Hawaii successive bands of missionary pioneers—Titus Coan, G. P. Judd, David P. Lyman, Father Bachelot, Father Damien, Brother Dutton, Levi Chamberlain, Daniel Dole.

The spiritual ideals which those devoted men and women planted on these Islands are bearing fruit to-day as useful to Hawaii and to the United States as the fruit of the *Mayflower*.

In six years they translated the Bible into the Hawaiian language, which they had reduced to writing; in 30 years they taught the entire nation to read and write, so that at one time in the nineteenth century it was the boast of the islanders that they were the most literate people in the world, with the smallest percentage of persons who could neither read nor write.

They saved the Hawaiian race from such ravages of disease and ignorance as decimated the islanders of the South Pacific.

They hitched Hawaii's wagon to a star. They pointed the way which their descendants and the thousands of splendid men and women who have since made the Hawaiian Islands their home have zealously followed.

It was their children and grandchildren who guided the successive sovereigns of Hawaii in preventing its absorption by European powers, and who, when the islanders had outgrown the monarchy, led the movement for independence and ulti-

Photograph by Robert K. Bonine

A RICE FIELD ON THE ISLAND OF OAHU

In the right background rises the "Punchbowl," crater of an extinct volcano in the center of Honolulu. It has been proposed recently to erect in this crater a huge modern athletic stadium, having a seating capacity of 95,000. A football gridiron, baseball diamond, cinder paths for track meets, and a number of tennis courts will be constructed on the floor of the bowl.

mate entrance of the Territory of Hawaii as an integral part of the United States.

ANNEXATION A BOON BOTH TO THE UNITED STATES AND HAWAII

The annexation of the Hawaiian Islands by the United States has turned out to be as good a bargain for the entire United States as it has proved for the Islands themselves.

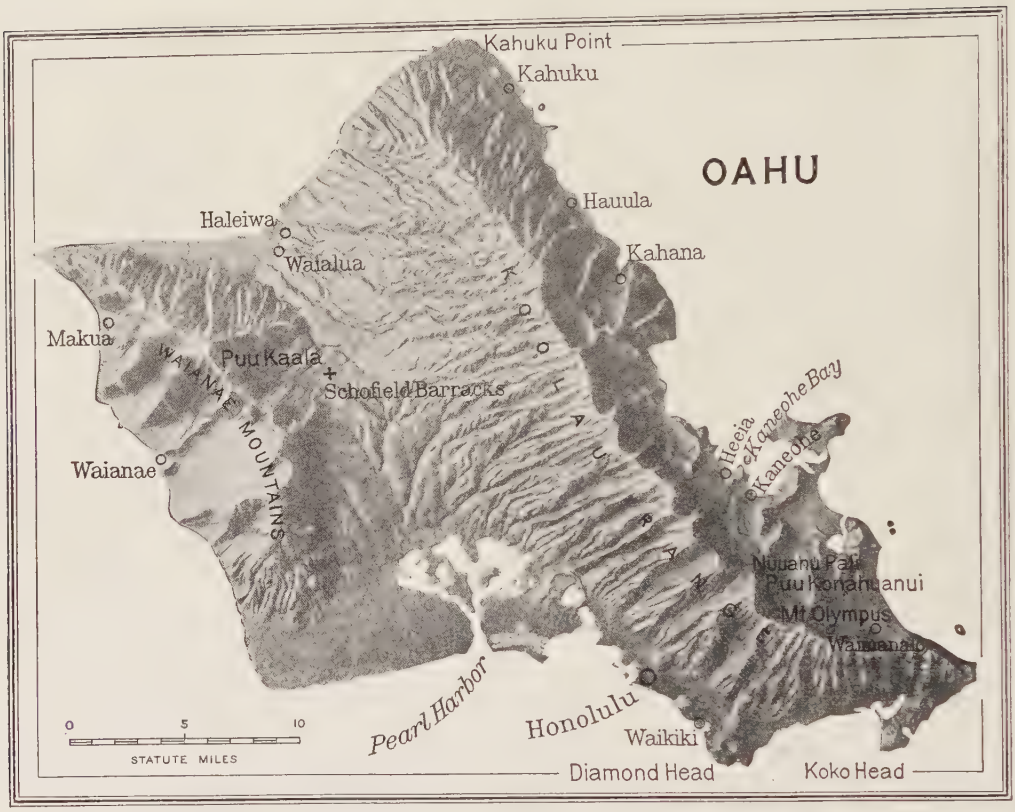
Great as is the value of Hawaii as the first line of America's military and health defense in the Pacific, these advantages are ours without the net expenditure of a single dollar of mainland money.

The people of Hawaii not only pay for the operation of their own government, but in addition contribute largely to the National Treasury at Washington to reimburse it for present-day expenditures for the Territory's defense.

In the fiscal year of 1921 the people of the Territory of Hawaii paid into the Federal Treasury, in customs duties, income taxes, and internal revenue taxes, a sum in excess of $22,000,000; in 1922 they paid more than $16,500,000. The cost of maintaining the customhouses, the Federal courts, the postal establishment, and other national functions in the Islands represents a very small fraction of these Federal taxes remitted by the Territory to Washington.

Easily, the net payments into the Federal Treasury at Washington in 1921 and in 1922 were much more than the outlay in recent years for fortifications and naval-base improvement, which fortifications, be it remembered, are primarily for the benefit of the whole United States.

Indeed, these payments go far toward covering also the entire cost of main-



A RELIEF MAP OF THE ISLAND OF OAHU

From this sketch the reader can easily picture the precipitous ravines that have been gouged by the torrents of water which, carried by the easterly trade winds, are intercepted by the mountain tops (see pages 141 and 145).

taining such troops as are necessary for the peace-time protection of the Islands and of providing post facilities for such additional troops as would be required for a war-time garrison.

The revenues which the people of Hawaii forward to the Washington Government equal all that they spend for the maintenance of their schools and roads, police protection, agricultural research, health agencies, etc.

Thus not only do they give Uncle Sam a dollar for every one they spend on themselves, but they do it with a willingness and a pride in the causes of the Nation that make them peculiarly entitled to the consideration of their fellow-countrymen on the mainland.

The quarter of a century that has now passed since the American flag first floated over Hawaii has seen its people develop a loyalty to that flag and a devotion to the Republic's ideals that are not excelled even in those States whose proud boast may always be that they are of "The Original Thirteen."

HAWAIIAN ISLANDS ARE NOT "INSULAR POSSESSIONS"

The people of Hawaii are sensitive on the score of the popular misconception obtaining in America, that their territory is one of the *insular possessions* of the United States. Only a few months ago the territorial legislature passed an act, characterized as a Bill of Rights, setting forth the fact that the Islands became an integral part of the United States by treaty rather than by purchase or conquest. The distinction, their citizens maintain, should entitle them to all the benefits of congressional legislation and appropriations in aid of good roads, education, farm loans, maternity, home economics, training in agriculture, trade and industry, and other acts of a like nature

Photograph by Herbert B. Turner

THE PUBLIC LIBRARY, HONOLULU

Becoming aroused some years ago by the increase in garish advertising billboards which interrupted the lovely vistas of mountain and turquoise sea, the women of the Outdoor Circle notified the merchants of Honolulu and of the mainland that they would purchase no goods so advertised. They prosecuted their campaign so vigorously that to-day there is not a single advertising billboard on the island of Oahu. These ladies were instrumental also in planting thousands of oleanders, pink and yellow shower-trees, poincianas, coconuts, etc., which now in gorgeous bloom decorate every landscape.

THE FUNERAL OF A HAWAIIAN PRINCE

Photograph and copyright by Roselle F. Faast

THIRTY-TWO GIRLS, EACH OF A DIFFERENT RACE OR RACIAL COMBINATION, ALL ATTENDING KAWAIAHAO SEMINARY, HONOLULU: A STRIKING ILLUSTRATION OF THE MIXTURE OF RACES THAT IS TAKING PLACE IN HAWAII

1. Hawaiian; 2. Ehu Hawaiian; 3. Japanese, 4. Chinese; 5. Korean; 6. Russian; 7. Filipino; 8. Portuguese; 9. Polish-Russian; 10. Hawaiian-German; 11. Hawaiian-Chinese; 12. Hawaiian-Russian; 13. Hawaiian-American; 14. Hawaiian-French; 15. Hawaiian-Portuguese; 16. Hawaiian-Filipino-Chinese; 17. Hawaiian-Indian-American; 18. Hawaiian-Japanese-Portuguese; 19. Hawaiian-Portuguese-American; 20. Hawaiian-Spanish-American; 21. Hawaiian-German-Irish; 22. Hawaiian-Spanish-German; 23. Hawaiian-Chinese-American; 24. Hawaiian-Portuguese-Irish; 25. Hawaiian-Japanese-Indian; 26. Hawaiian-Portuguese-Chinese-English; 27. Hawaiian-Chinese-German-Norwegian-Irish; 28. South Sea (Nauru)-Norwegian; 29. African-French-Irish; 30. Spanish-Porto Rican; 31. Guam-Mexican-French; 32. Samoan-Tahitian.

Photograph from Howard D. Case

THE AUDIENCE AT AN OPEN-AIR MOTION-PICTURE SHOW

Honolulu public school children of Central Grammar School at a community picture.

JAPANESE CHILDREN CELEBRATING A FLOWER FESTIVAL: HAWAIIAN ISLANDS

Photographs by Robert K. Bonine

THE SOCCER FOOTBALL TEAM OF THE MID-PACIFIC INSTITUTE, AT HONOLULU

which apply to the States of the Union as a whole, but which have not been extended to Hawaii.

Nineteen States, including Nebraska, Maine, Florida, Alabama, South Carolina, Arkansas, New Hampshire, Delaware, Utah, Mississippi, Vermont, Montana, South Dakota, Arizona, Idaho, Wyoming, North Dakota, New Mexico, and Nevada, paid less per State into the National Treasury in 1921 than did Hawaii. Each is allotted Federal aid, but the Territory of Hawaii is excluded.

EXPECTATIONS MORE THAN REALIZED

Our visit was in the months of June and July. Here again we found we were running contrary to prevalent advice. "Going to the subtropics in early summer? A geographer ought to know better," was the frequent comment of our friends; but our expectations of a delightful season were more than realized.

The voyage from the mainland occupies six or seven days, through quiet seas that become daily more enchanting in color and in charm of cloud and sky as we approach the Islands.

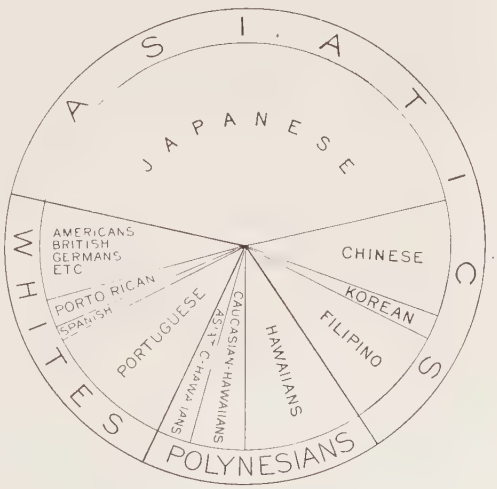
Nor does the visitor, however well prepared by reading and by conversation with Hawaiian advertisers, escape amazement at the great enterprising metropolis of Honolulu which greets him in these lonely islands in mid-Pacific—vociferous taximen, flivvers and luxurious limousines, spacious hotels, many miles of suburban concrete roads; morning and afternoon newspapers that publish long press dispatches from the mainland and even give the daily quotations of the New York stock markets and the big league baseball scores; large department stores thronged with buyers and displaying the latest New York, London, and Paris fashions; a great university plant and fine public school buildings; a superb country club, with golf courses that can compete with our best national links; a Carnegie library; electric trolley cars whose fares are regulated at Washington, 5,000 miles away; a canning factory that puts up more than one million cans of pineapples in one day, a world-famous agricultural experiment station, and countless other manifestations that we have entered an American-minded community.

"The mercury stands at 80°, but there

NOTICE
WALKING ON THIS BRIDGE PROHIBITED
KAPU AOLE HELE MALUNA O KEIA UAPO.
NESTA PONTE E PROBIDO PASAR QUAL QUER PESOA.
H.R.T.&L.Co.

Photograph by Harriet Chalmers Adams

A NOTICE POSTED IN FIVE LANGUAGES: ENGLISH, HAWAIIAN, PORTUGUESE, CHINESE AND JAPANESE



A DIAGRAM SHOWING THE RACIAL PROPORTIONS OF THE POPULATION OF THE HAWAIIAN ISLANDS

Photograph by Robert K. Bonine

"MORE THAN 40 PER CENT OF THE POPULATION OF THE HAWAIIAN ISLANDS IS JAPANESE" (SEE TEXT, PAGE 176)

is no sultriness: a tremulous sea breeze and a mountain breeze fan the town, and the purple nights, when the stars hang out like lamps and the moon gives a light which is almost golden, are cool and delicious."

Our first excursion is up Nuuanu Valley to view the grand panorama from the precipice called the Pali (see page 118), which is Oahu's scenic lion.

Geologists assert that we are looking down into what is left of an immense volcanic crater which ages past was 25 miles in diameter. One-half of the crater has sloughed off into the ocean.

"The Pali is a natural wonder, that as a genuine surprise has nothing to equal it in all the world. From its sheer edge, the splendid panoramic view of the windward side of the island is spread out at the observer's feet—a view of rugged mountains, of cliffs, of country side, of quiet bays, of coral strands, and of the open sea that has beggared the descriptive powers of the most gifted.

"Here the observer comes to appreciate not only the stupendous constructive power of Nature that has called the island into being, but also those destructive agencies which, through countless cen-

turies, have been tearing down the solid rock, disintegrating, transporting, and distributing it, according to well-established natural laws." *

With its long, vertical crater wall standing abreast of the northeast trade winds, and with the elevation and other conditions favorable to bring about an abundant rainfall on the leeward side, it has been furrowed from end to end into a series of deep lateral valleys, like the fluted pipes of an organ.

Perhaps our most vivid memories of this world-famous view are the enchanting notes of the Manchurian thrush which, imported some years ago, now nest abundantly among the peaks and cliffs, and which were calling to their mates in exquisite song.

Judging from our experience, the trades rush across the Pali with as great force as when Admiral Wilkes visited it 80 years ago and noted in his record, "On reaching the Pali beware of losing not only your hat, but yourself; for when the trade is blowing strong, it is impossible to stand with safety."

Photograph by Herbert B. Turner

A PICTURE BRIDE: HONOLULU (SEE PAGE 176)

These Hawaiian mountains, rising from the water to 5,000, 10,000, and 13,000 feet, have given the Territory of Hawaii a variety of climate that is unique.

I quote from Lawrence H. Daingerfield, the brilliant meteorologist, who for several years was the division chief of the United States Weather Bureau, stationed at Honolulu:

"One would have to travel far afield to discover another area of 6,454 square miles, constituting the eight main islands of the Hawaiian group, over which so wide a range of rainfall may be gaged.

SOME PHASES OF HAWAIIAN CLIMATE

"Nestled in the lap of the great Pacific and crescented like the bow of some giant archer, the islands are subject to the caressing and sometimes battling trade winds bringing from the sea their burden of moisture. These trades are the old faithfuls that sweep the windward plains, slopes, and palis and bathe the mountain crests and precipices with some of the greatest torrents from the clouds known to man.

"Yet, when we pass down the leeward slopes and out over the volcanic red plains, we find a dry realm of such startling

* From William Alanson Bryan's very remarkable work, "Natural History of Hawaii."

Photograph by Dr. Albert S. Baker

A NINETY-SEVEN-YEAR-OLD HAWAIIAN IN FRONT OF HIS COFFEE TREES: KONA, HAWAII

Kona coffee is famous with all who know it. An acre of trees has yielded as high as 24 hundred-pound bags of dry coffee.

Photograph by Robert K. Bonine

THE VILLAGE OF WAIOHINU, WHERE MARK TWAIN PASSED "A YEAR OF VAGABONDAGE"

He was refused a job on a newspaper in Honolulu because the editor declared he appeared to be too lazy.

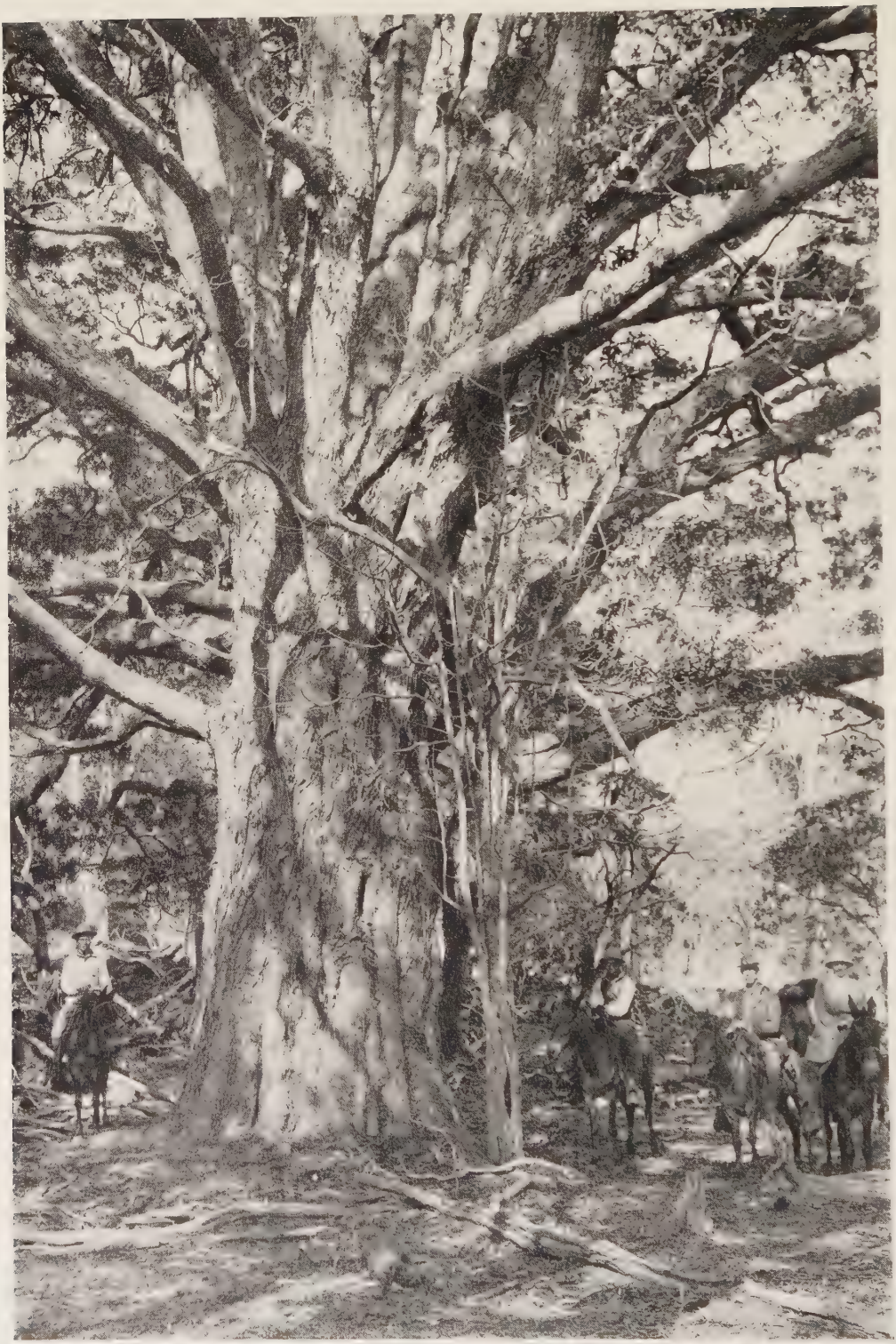
Photographs by Dr. Albert S. Baker

SAILORS FROM THREE VISITING WARSHIPS CLIMBING THE NEARLY PERPENDICULAR WALLS OF THE PALI

They are about to enter the ancient burial caves near the monument to Captain Cook, discoverer of the Islands (see text, page 117).

ANCIENT SALT WORKS FOR THE EVAPORATION OF SEA WATER: ISLAND OF HAWAII

Water shows in three of the dozen large hollowed stones near the modern lighthouse, not far from where Captain Cook was killed.



Photograph by Gilbert Grosvenor

A GIANT KOA TREE IN THE BIRD FOREST, HAWAII NATIONAL PARK

It was from similar trees that the ancient Hawaiians with their stone implements laboriously hewed their ocean-going canoes (see text, page 116).

contrast that much substantiation is necessary to be convincing.

"Awini, at an elevation of 2,100 feet in the North Kohala hills of Hawaii, has an annual rainfall of 167.68 inches, while a yearly amount of only 16.60 inches is gaged at Mahukona, about nine miles leeward.

"Nahiku, windward of Haleakala, Maui, receives annually about 300 inches, while Waiopai Ranch, leeward of Haleakala, and perhaps 14 or 15 miles from Nahiku, gages normally only 25.39 inches.

"Puu Kukui (Upper), West Maui, elevation 5,000 feet, receives normally 370 inches, while Camp No. 7, only about 8½ miles distant, near the west side of the Maui Isthmus, elevation 90 feet, receives only 15.66 inches.

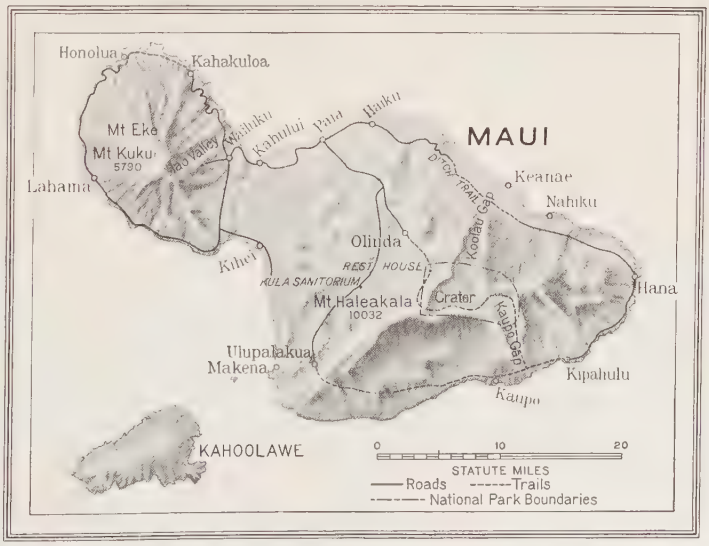
"The greatest and least amounts of precipitation ever gaged in the Territory in a full year are likewise found at Puu Kukui (Upper), which received 562 inches in 1918, and Camp No. 7, with only 2½ inches in 1912.

"The wet places mentioned are dry, however, when compared with Mt. Waialeale, Kauai, elevation 5,080 feet, and the crest of the island. Here is gaged annually a normal amount of approximately 476 inches—an amount probably unequaled elsewhere in the world, as Cherrapunji, in the Khasi Hills of India, long a claimant

Photograph from L. W. de Vis-Norton

THIS WEARY OLD TREE IS THE PROGENITOR OF MANY THOUSANDS OF ALGAROBA TREES

This species now affords food, fodder, firewood, and shade in areas that, previous to its introduction by Father Bachelot nearly 100 years ago, were arid deserts.



Drawn by A. H. Bumstead

RELIEF MAP OF THE ISLAND OF MAUI

Photograph by Robert K. Bonine

ON THE RIM OF HALEAKALA, THE WORLD'S LARGEST DEAD VOLCANO: (SEE ALSO COLOR PLATES VIII AND IX)

Photograph by Dr. Albert S. Baker

THE ENCLOSING WALL ACROSS AN ARM OF THE OCEAN FORMING AN ANCIENT FISH POND NEAR HILO, HAWAII

The fish kept inside the enclosure are chiefly mullet (see also page 122).

Photograph by Gilbert Grosvenor

A VIEW OF A SMALL CORNER OF HALEAKALA CRATER, ISLAND OF MAUI

Ages ago its fires were stilled and the scene of its former fury is now one of the coldest places in the Pacific. Peering through the clouds, 100 miles away, are the summits of Mauna Kea and Mauna Loa on the island of Hawaii (see Color Plates VIII and IX).

for first honors for wetness, seems to have fallen into second place, with 426 inches of rain annually.

"Only some fourteen or fifteen miles leeward of Mt. Waialeale, however, we find a quick surrender to dryness, and Waiawa, at an elevation of 35 feet, receives annually a normal amount of 22.21 inches.

"The higher levels of Mauna Loa and Mauna Kea, Hawaii, and Haleakala, Maui, are frequently white with snow during the colder months of the year, and transient snow has been seen on the crest of Mt. Waialeale, Kauai. It is not unusual to see snow banks on the crests of Mauna Kea and Mauna Loa in midsummer, thus indicating persistent frost at those desolate altitudes, even though tropical verdure luxuriates at their bases in perennial summer.

"It is doubtful if frost ever forms much, if any, below the 2,500-foot level over the entire group of islands, and rarely below 4,000 feet.

"The tenaciousness of the trade winds through all seasons and over all islands of the group (aside from a limited area leeward of Haleakala and over the Kona districts of Hawaii), the persistently equable temperature which passes through the cycle of seasons devoid of extremes, the abundant moisture, especially over the windward slopes, and the lack of tropical storms, known elsewhere in the Tropics as typhoons or hurricanes, add to the desirability of the climate from the standpoint of recreation and pleasure, as well as the more practicable pursuits of life.

"From the warmth of the continuous low-level summer to the chill of the persistent high-level winter, from the arid plains to zones of frequent and heavy rains, from the sunshine of Lahaina, Honolulu, and Waimea districts to the cloud- or fog-draped crests of Mauna

THE LOVELY STRAND OF PUNA: ISLAND OF HAWAII

The visitor finds endless enjoyment in the contrast of the pure-white surf and jet-black sand, which sparkles like anthracite and is as clean as snow; in the rustling green palms, the soft, sweet fragrance of the ocean zephyrs, and the exciting search for great sea turtles which abound along this shore.

Photographs by Gilbert Grosvenor

A LAVA ROCK HURLED ABOVE THE CLIFF BY A TIDAL WAVE: PUNA

Photograph by George Shiras, 3d

LOOKING DOWN UPON THE LEPER SETTLEMENT ON MOLOKAI

Loa, Mauna Kea, Haleakala, and Waialeale, one finds, perhaps, greater climatic changes than can be found elsewhere upon the face of the earth within so limited an area."

THE VISITOR CAN CHOOSE HIS OWN CLIMATE

Roughly computed, the annual mean temperature is 75.55°, with a divergence in either direction of 7.55°. As a general rule, the temperature is cooler by four degrees for every thousand feet of altitude, so that people can choose their climate to suit themselves without leaving the Islands.

We had an amusing illustration of the variety of climate on Oahu. We had requested the privilege one morning of viewing a noted Japanese garden at Waikiki. The owner, with typical Hawaiian hospitality, immediately assented, and added that his wife would be happy to receive us, but he was not sure that he could locate her at such short notice. He had a town house in Honolulu, the Japanese villa at Waikiki for surf-riding, a mountain retreat on Nuuanu, a ranch house on the dry plateau near Schofield Barracks, and a bungalow on the rainy northeast shore. All these establishments were within two hours' ride, and yet each had an entirely different atmosphere. As he had failed to ask his wife in the morning what kind of climate she had selected for the day, he was at considerable trouble to find her.

SUGAR PLANTATIONS ESTABLISH WORLD-FAMOUS EXPERIMENT STATION

The 47 sugar-producing corporations of the Islands have combined to support a world-famous experiment station in Honolulu, so that whatever one producer learns in the way of making his acres yield more sugar and of reducing the per-pound cost of production at once becomes the property of all.

Samples of soil from every cane field in the Islands are forwarded yearly to the experiment station, where they are analyzed and an appropriate ration formulated for the field, and the type of cane selected that experience has proved will do best on that particular soil. Every sugar planter contributes to the support of this station.

Soil analysis, seedling introduction,

A PORTRAIT OF OLD STUMPLEG, WHOSE UNIQUE CAREER IS DESCRIBED IN THE TEXT (SEE PAGE 189). DRAWING BY LOUIS AGASSIZ FUERTES

cane-disease prevention, variety adaptation, and parasite elimination have all served to enable the Territory of Hawaii to lead the world in the acreage production of sugar and have made all sugar-yielding centers look to it for guidance in the handling of the industry.

On the windward side of the island of Hawaii sugar can be grown without irrigation. The rainfall is abundant, frequently exceeding 200 inches a year—upward of 22,000 tons of water per acre, or more than half a ton per square foot. Here there is plenty of water for use in flumes, big V-shaped troughs, miles long, carrying streams of water into which the cane is thrown and washed down to the mills (see page 167).

On the lee side of this island, however, and on all of the producing areas of the islands of Kauai, Oahu, and Maui—for the mountains come down to the coast on the windward side of the latter three and leave no room for cane fields there—the crop is produced entirely by irrigation.

Nowhere else can one find a better illustration of how the genius of man can transform adversity into advantage than in the story of Hawaiian sugar on Oahu, Maui, and Kauai, where, lacking water during the dry seasons, the planters dug irrigation ditches and impounded the excess waters of rainy periods, and now are able to grow more cane to the acre than the best naturally watered sugar lands in the world can produce.

Irrigated Maui Island produces approximately 15,000 pounds of sugar per acre year after year;* unirrigated Hawaii Island produces 8,000 pounds. Cuba produces during an average year 4,900 pounds per acre, and Louisiana 2,620 pounds.

Some of the irrigation systems of the larger plantations are of amazing proportions, well justifying the assertion that the Hawaiian plantation managers are "the most daring and successful land reclaimers in the world."

The first irrigation ditch in the Islands was dug in 1857. Now there are thousands of miles of ditches and hundreds of miles of tunnels carrying water to the cane.

In the island of Kauai two plantations under one management have forty miles

*A single acre under irrigation has produced as much as 10½ tons.

Photograph by W. K. Fisher

A STUDY OF FLIGHT, ON LAYSAN ISLAND, A TERN (*Sterna fuliginosa*) COLONY

of tunnels and ditches. Another plantation has one tunnel more than six miles long.

A plantation on the island of Oahu has an aqueduct nearly fifteen miles long, ten miles of which is tunnel. This aqueduct taps four valleys and in order to do so had to pierce the Koolau mountain range with a tunnel 14,443 feet long.

ONE PLANTATION USES AS MUCH WATER AS THE CITY OF SAN FRANCISCO

Vast reservoirs for impounding water are constructed in the mountains so as to maintain a constant supply, which, at times, reaches a total of 50,000,000 gallons a day. One plantation requires as much water to keep its cane growing as San Francisco requires for all purposes.

Much of the water for irrigation purposes must be pumped from artesian wells, of which there are thousands. Realizing that the water supply from these wells can be maintained only by retarding the flow of the mountain streams to the sea, extensive reforestation work has been undertaken.

It has been estimated that half a ton of water is required for each pound of sugar produced. On this basis the average American, consuming upward of eighty pounds of sugar a year, needs forty tons of water for his sweet tooth alone.

More water is required on Hawaiian sugar plantations than in Cuba, as the Cuban cane reaches maturity in twelve months, whereas Hawaiian cane needs seventeen months to be ready for the harvest. This partially compensates for Cuba's smaller production per acre.

Photograph by W. K. Fisher

ONE OF THE LARGE ALBATROSS COLONIES, MOSTLY YOUNG BIRDS, ON LAYSAN ISLAND, TERRITORY OF HAWAII

To this tiny island millions of albatross, plover, tern, and man-o-war birds journey annually to rear their young. Because of its remoteness from the mainland, 2,000 miles distant, this bird colony is considered the most remarkable known to science (see text, page 189).

By intelligent selection of cane varieties, each being grown in the soil shown by experimentation to be especially adapted to its development, the Islands have been able nearly to double Cuba's per-acre production of cane, and have also produced cane yielding 15 pounds more sugar to each ton.

The story of the sugar industry in Hawaii is one that varies radically from that of the Cuban industry in many of its details.

Much of Hawaii's crop, as previously stated, is produced on irrigated lands, while very little of Cuba's can be.

A considerable part of Hawaii's cane is transported to the mills by flumes, while none of Cuba's product travels in such fashion.

Hawaii makes extensive use of fertilizer; Cuba relies very largely on the natural productivity of the soil.

Cuba's production per acre of both cane and sugar seems large contrasted with most other sugar-producing regions of the world; but it seems small compared with Hawaii's yield.

THE BATTLE BETWEEN PLANTERS AND INSECT PESTS

There is no phase of Nature in Hawaii more dramatically interesting than the struggle between the sugar planters and the insect enemies of cane. In countries to which various forms of animal life are native there are always parasites which prey upon them and hold them in check. But introduced forms of life which find living conditions to their taste and natural enemies wanting, get a foothold and make a headway that is scientifically startling and economically dangerous.

Nowhere else in the world is that condition better exemplified than in Hawaii. With a climate ideally suited to the requirements of innumerable tropical and subtropical insects, and with food supplies luxuriant and perennial, when one of these species effects a landing as a stowaway from some other country, it promptly begins to spread and, without natural enemies to attack it, rapidly colonizes the country.

Typical among the stowaways that came to Hawaii in years gone by are the cane borers and the cane leaf hoppers. The borer is a beetle and the hopper a kind of plant louse. They effected their entrance on importations of cane seed and cuttings.

As years passed they both became so numerous that they threatened utterly to destroy the sugar industry of the Islands. With such a menace, the Hawaiian sugar planters organized an experiment station whose duties should include the discovery and importation of natural enemies of the borers and the hoppers.

How these enemies were found, colonized and set to work on the borers and hoppers is one of the remarkable romances of the sugar industry.

In 1906, Mr. F. Muir began a quest for the enemies of the stalk-riddling cane borer, whose evil disposition justifies its scientific name, *Rhabdocnemis obscurus*. First he went to China, but no borers were found. Then he visited the Federated Malay States, and from there journeyed to Java, but without success.

Discouraged, he was about to content himself with some cousin of the borer, ascertain its enemies, and import these into Hawaii, in the hope that they would attack the borer there as valiantly as they attack the borer's cousins elsewhere. But then he remembered that parasites are constant creatures, with their tastes running so much in a groove that they perish rather than change their habits even so slightly as a swapping of hosts might involve.

He therefore headed for Borneo, but neither in the field nor in the Sarawak Museum could the borer be found. He was about ready to admit that *obscurus* was a good name.

From Borneo Mr. Muir retraced his steps to Java, and thence shipped to the Molucca Islands. Visiting Amboina, of this group, he still found no trace of the borer, and the natives did not recognize the specimens he had brought from Hawaii.

THE BORER'S DEADLY ENEMY IS FINALLY FOUND

Again he set forth, proceeding to the island of Larat, via Kei and Aru Islands, and finally located borers not only in sugar cane, but also in pinang and sago palms.

Now that *obscurus* stood revealed, where were its parasites? He searched

Photograph by R. W. Perkins

A SIZABLE CATCH OF HAWAIIAN SHARKS

In ancient times, shark fishing was a royal sport, and it is said that the chiefs used human bait for their large bone and wooden hooks, which were sometimes more than a foot in length. Kamehameha I was especially proud of his title, The Great Shark Fisher.

high and low, far and wide; none was to be found.

Finally he seized upon a forlorn idea: If the borer lived in palms in Larat, might it not also have the same habitat in Amboina? Going back to that island, he found the surmise correct. The borer was abundant in the sago palm, and there he found it attacked by a little fly that laid its eggs in the borer's larvæ.

Here, then, was Hawaii's salvation from the borer if—if the friendly fly could be imported to the Islands. Repeated efforts to forward the flies and their pupæ failed—they always died before arrival in Honolulu. At last Mr. Muir decided to accompany a shipment himself, and journeyed safely with them to within a single day's sailing of Honolulu, only to have them die without apparent cause.

Back to the Moluccas he was forced to go again. Visiting Ceram Island, he found conditions about the same as in

SURF-RIDING: DIAMOND HEAD RISES IN THE DISTANCE

Few aquatic sports afford a thrill equal to that of surf-riding. The swimmer with his surfboard, from 7 to 12 feet in length and 1½ feet in width, works his way out through the shallow water over the fringing coral reef to where the high rollers rise. Selecting his wave, he gets his boat under way by paddling furiously with his hands and feet, and at the proper moment, mounting a high wave, throws himself on the board just as it is seized by the force of the onrushing water, which carries him with race-horse speed toward the beach.

Photograph by Henry W. Henshaw

HAULING IN A SEINE ON THE BEACH AT HILO

Photograph by Gilbert Grosvenor

APÉ-APÉ FOLIAGE IN PUOHOKAMOA GULCH: ISLAND OF MAUI

The plant with huge umbrella leaves is the Ape-ape (*Gunnera petaloides*) which millions of years ago flourished on all the continents. It grows to-day only in the Hawaiian Islands. The human figure gives an accurate conception of the size of this strange beautiful vegetation, for he stands in the same plane as the plants, which were growing on the slopes of the extinct volcano Haleakala, in a small gulch which had the hot, moist fragrance of a greenhouse. The photograph was taken from the cliff directly opposite while a light rain was falling (see pages 176-177).

Amboina, and then decided to go to New Guinea. At Port Moresby, on the latter island, he heard that the flies he sought were up Laroki River. He visited a camp 15 miles up the river and, finding them, stocked a number of cages with borer larvæ in which the parasitic fly had laid its eggs, and, though suffering from incipient typhoid fever, he set out via Brisbane, Australia, for Honolulu with his precious parasites.

But again fate was against him. At Brisbane he had to go to the hospital, after dispatching his flies unattended. They died long before their ship sighted the mid-Pacific's magnificent harbor.

Once more able to travel, Mr. Muir went to the Hawaiian mountains to recuperate, and then set out for Papua. This time he decided to establish two half-way breeding stations—one in Australia, and the other in the Fiji Islands. Arriving in Papua he collected more borer larvæ parasitized by the much desired fly, and in spite of an attack of malaria, he set out for Fiji. Here he had to go to the hospital again, but not until he had built a breeding cage for the flies.

At last he recovered, and with reinforcements brought by an associate, finally arrived in Honolulu with living flies on August 16, 1910, more than four years after starting on his quest.

Once safely in Hawaii, the flies began to spread with great rapidity and to work havoc among the borers, laying their eggs in vast numbers in the young of the borers.

So effective were these parasites that the borer has become a negligible factor in the cane-growing situation. The yield of sugar per ton of cane has gone up, the yield of cane per acre has increased, and a menace that threatened to overwhelm the industry has been thwarted. On one plantation the number of borer beetles collected declined in two years from 27,010 to 1,568.

Meanwhile, the borers becoming scarcer as a result of the attacks of the fly, the latter has also become scarcer because it has not learned how to gain a living off of any other kind of insect. But it ever stands guard against the borer, for just as soon as there is a new flare-up of borer activity, the flies begin to multiply again and continue to swell their armies until the borers have been duly subjugated.

An even greater menace to the sugar industry than the cane borer developed two decades ago when the leaf hoppers grew numerous. Any one familiar with the rose chafer and such small creatures of our dooryards knows the hopper type of insect. On a single infested sugar plantation production fell from 19,000 tons to 3,000 tons in three years. The hoppers punctured the stalks and leaves of the young cane and laid their eggs by the thousands in these punctures. Hatching out, the youngsters sucked the juices of the plant, thereby sapping its strength.

When the ravages became alarming, the entomologists of the Sugar Planters' Association were set to the task of finding where the hopper came from, and what its enemies were.

TINY ENEMY OF THE HOPPER FOUND

Finally it was ascertained that the pests had been imported as stowaways on seed cane brought from Australia. Going to the Library of the British Museum, in London, the entomologists found descriptions of the hopper and its native habitat, in Queensland, Australia. Visiting that country, they spent weeks hunting its natural enemies. One by one such enemies were discovered. One was an almost microscopic insect which, much as a mosquito attacks a human being, steals upon and attaches itself to the hopper's body, stinging it and laying a tiny egg beneath its skin. When this egg hatches the larva has such a tremendous appetite that by the time it is grown the hopper's interior department has been devoured and the parasite emerges ready to place its egg in some other animated combination incubator and larder.

The entomologists found another insect which, from the sugar growers' standpoint, has an even more successful plan of campaign against the hopper. It goes about seeking out hoppers' eggs in which to lay its own. Since its young hatch much more quickly than the hopper, they come to life in time to eat the hapless embryo hopper, and off of that feast to grow strong enough to lay eggs, in their turn, in the eggs of other hoppers.

Preyed upon by one class of enemies

that uses their live bodies first as incubators and then as restaurants, and by another class that uses their eggs as hatcheries and larders, the hoppers were forced to sound a retreat. Man had found irresistible allies, and so again the Hawaiian sugar industry was saved.

There is still another classic illustration in Hawaii of the incalculable value of the work of the entomologists to the human race. A wealthy Hawaiian visited Mexico, and found there a shrub which he greatly admired, and which he decided to take back to Honolulu with him. It was the lantana, growing some five feet tall, possessing a rich foliage, and bearing a brown, red and yellow flower. The slips grew wonderfully, and the shrub, away from its natural enemies, began to sweep over the island. Neither Canada thistle nor krautweed ever spread more like wildfire in a new environment than did the lantana. Pastures were ruined, and even the busy precincts of the cultivated fields were ruthlessly invaded by it. Again Hawaii went to her entomologists for relief.

Going to Mexico, the "bug specialist" visited the natural habitat of the lantana, and there found a fly whose special mission in life appears to be *to lay its eggs in the buds of the lantana. When these hatch out, the youngsters feast upon the lantana seeds.*

Brought to Hawaii, this fly, with no natural enemies, spread rapidly, and in a few years this Mexican shrub was relegated to the conquered dangers.

FRUIT FLY ATTACKS 72 KINDS OF HAWAIIAN FRUITS

Two other pests have been smuggled into Hawaii that are proving highly dangerous to the fruit and melon crops—the Mediterranean fruit fly and the melon fly.

The Mediterranean fruit fly is one of the most dangerous of all the fruit pests in tropical and semitropical countries. In Hawaii it attacks 72 different kinds of fruit. It obtained its first foothold in Honolulu in 1910, reaching Hawaii from the Mediterranean countries by way of Australia, and in four years had spread to every island of the group.

The method by which the fruit fly operates is for the female to drill little holes through the rind of a fruit and lay her eggs in them. The holes are so small that they escape observation, but in a few days the eggs hatch and the maggots, tiny things at first, begin to feed on the fruit. There is one fruit from which the fly derives no reward of posterity—the papaya, one of the commonest of the breakfast fruits of the Islands. It possesses such a rich supply of vegetable pepsin that it quickly digests the eggs of the fruit fly, thus preventing them from hatching.

There is no citrous fruit too acid for the appetite of the fruit fly's young, and lemons, grapefruits and limes are all "beer and skittles" to it. Four species of parasites that lay their eggs in the bodies of the fruit fly's larvæ, boring down through the rind of the fruit to reach them, have been imported from Africa and Australia.

The melon fly attacks melons in much the same way that the fruit fly plies its propagation practices. Its parasites have not yet been found, since the economic interests identified with melon growing have never been important enough to lead to the launching of a systematic campaign in quest of its natural enemies.

But both of these flies are potential stowaways to the United States, and the Department of Agriculture is sparing no effort to keep the quarantine bars so high that neither of them can effect a landing.

Yet the Department realizes that the danger is an ever present one, since there are always travelers who are either uninformed or careless, and who seek to conceal forbidden fruits about their persons or baggage. Some even send express packages whose contents are not truthfully stated.

The highest bars that a quarantine may raise cannot obviate the dangers of thoughtless or malicious introduction, and the Department appeals to every American to remember, when tempted to evade the law, the evils of the coddling moth and the English sparrow, and the browntail moth and the starling.

THE STORY OF THE PINEAPPLE IN HAWAII

We visited a pineapple cannery in Honolulu which employed 4,000 people, two-thirds of them women. Long trains of freight cars loaded with golden fruit were arriving every few minutes. The women were separated according to their

Photograph by Henry W. Henshaw

A HAWAIIAN LANDSCAPE

In the Hawaiian Islands to-day only fishermen when in action wear this abbreviated costume.

Photograph by Hawaiian Volcano Observatory

A RIVER OF MOLTEN LAVA FROM MAUNA LOA POURING INTO THE OCEAN

About 100 feet of land was built out where the ocean was formerly very deep. When this photograph was made boiled fish were still floating on the surface of the water, which was warmed for several miles.

Photograph by Lewis Edwin Capps

HEAVY SURF GIRDLES THE ISLANDS WITH PERPETUAL THUNDER: ON THE OAHU COAST

Photograph by Henry W. Henshaw

A SAILING DOUBLE CANOE SKIRTING THE SHORES OF COCONUT ISLAND NEAR HILO

Photograph by Henry W. Henshaw

AN AFTERNOON SHOWER: ON THE RIGHT A FIELD OF SUGAR CANE IN FLOWER: HILO

Photograph by Henry W. Henshaw

A GIANT TREE FERN ON THE ISLAND OF HAWAII

There are no less than 130 species of ferns, varying in height from a few inches to many feet, in the Hawaiian Islands. They form an especially luxuriant undergrowth in the ohia-lehua and koa forests. The koa is the famous "Hawaiian mahogany," from which the natives used to fashion their dugout canoes. On account of the isolation of the islands, the proportion of plants peculiar to the group is greater than in any other part of the world.

Photograph by Gilbert Grosvenor

THE ROADSTEAD AT LAHAINA: THE ISLAND OF MAUI

During the first half of the last century an American whaling fleet assembled here annually. The picture was taken from the terrace of the Manual Training School at Lahainaluna, one of the first manual training schools of the New World. It was on Maui that General Armstrong was born, and it was the success of this mission school in helping the native Hawaiians that inspired him to found the Hampton Institute for Negroes and American Indians.

Photograph by Henry W. Henshaw

IN THE HARBOR OF HONOLULU

Photograph by Henry W. Henshaw

A SUGAR-CANE FLUME NORTH OF HILO

Aqueducts on trestles of wood convey the sugar cane from the fields to the mill where the cane is ground and the juice extracted.

Photograph by R. W. Perkins

PLOWING RICE FIELDS WITH WATER BUFFALO: OAHU

CHILDREN CLOTHED IN NOTHING BUT SUNSHINE

© R. J. Baker

Photograph by Joseph F. Rock

THE IMPOSING CLIFFS OF IAO VALLEY, ON THE ISLAND OF MAUI: THE DARK VERTICAL STREAKS BECOME WATERFALLS DURING RAINSTORMS

Behind the clouds is Mt. Kukui, which has a record of 562 inches of rainfall in one year. In the recesses of this beautiful valley, which resembles the Yosemite Valley of California, dead kings were concealed so that no commoner might steal their bones to make fish hooks.

Photograph by Gilbert Grosvenor

A CLIFF SIDE IN A LUXURIANT GLEN ON THE SLOPES OF HALEAKALA, MAUI

The human figure leaning against the cliff suggests the size of the giant umbrella leaves of the ape-ape and of the long graceful ferns (see also pages 156, 164, and 172).

Photograph by Alonzo Gartley

A GULCH IN KAUAI, HAWAIIAN ISLANDS

As a result of their isolation and their freedom from geological changes for thousands of centuries, the Hawaiian Islands have evolved a remarkable and virgin flora. Six hundred and fifty species found nowhere else in the world have developed in these islands. Kauai, being the oldest island, has the majority of these new varieties, and Hawaii, being the youngest island, has the least number.

Photograph by J. Senda

WAILUA FALLS, ON THE ISLAND OF KAUAI

The greatest rainfalls recorded by meteorologists have gouged deep canyons and ravines and gradually carved on the little island of Kauai a system of gorges unique on the face of the earth. Waimea Canyon (Color Plate II) is a miniature Grand Canyon, not so deep, but even more gorgeously colored. The color scheme is heightened by flocks of large white birds, with unusually long white tails, which are forked like swallows' tails, hovering against the bright red walls and deep indigo sky.

Photograph and copyright by Robert K. Bonine, of Honolulu

THE FAMOUS SILVER SWORD PLANT OF HALEAKALA, FOUND IN THE EXTINCT CRATER OF HALEAKALA, ON THE ISLAND OF MAUI

This specimen stands about five feet high; the leaves, three-cornered in shape, and the central stem are of a soft silvery gray, and the flowers are light yellow with brown centers. It was in former times quite plentiful in the crater, but of late years goats have been grazing here and they have despoiled many plants.

race: the Chinese at one set of tables, the Japanese at another, etc., and each group was striving to eclipse the record of the others. The fruit was not touched by the bare hand from the moment it left the train.

The story of the pineapple in Hawaii is one of the most fascinating horticultural romances of that romantic group of Islands. Once torn from the soil and cast upon a rubbish heap as less than worthless, its cultivation and canning today constitute the second industry of the Territory, the value of its crop being exceeded only by that of sugar cane.

The first pineapples in Hawaii were brought from the East Indies and were planted a few years ago on the island of Oahu. The failure of the venture was due not to the failure of the plant, but to its abundant success; the yield was so plentiful that the fresh-fruit market of Honolulu was soon flooded and the venturesome planters had to accept a heavy loss. Wisdom seemed to prompt the pioneers to uproot the plants and cast them like tares into the fire.

A few homesteaders, however, enamored of the flavor of the new fruit, rescued some of these uprooted pineapples and transplanted them to their own gardens. Again they bore wonderfully.

In time these new friends of the crop established a cannery for the surplus fruit and from this modest beginning has developed an industry which in 1923 shipped more than five million cases of canned fruit to the markets of the world.

The pineapple makes few demands upon the cultivator—a loose soil, a reasonable amount of moisture and, above all, good drainage.

Frequently, when a field is to be planted in pineapples, enormous ribbons of heavy paper are spread upon the ground in parallel lines, with only a narrow space between them. The young plants are set out in holes cut in the paper, which forms a tough coverlet, permitting them to grow sturdily, yet smothering any weeds which attempt to compete with them.

Wind and rain eventually destroy the paper, but not until the plants have established themselves and are in a flourishing condition. This novel method of planting is supposed to have increased the size of the pineapples one-fourth and to have added some eight tons to the acreage yield.

The fruit is protected by sharp, spiny leaves and the gatherer must wear heavy gloves and leggings to protect himself from the saw-tooth edges.

The "pines," as they are universally called in the Islands, are harvested ripe for canning. Machines have been devised which peel the skin from the barrel-shaped apple, carve out the core, and slice the tender fruit into golden disks.

The fruity cores are chopped into bits for the use of confectioners and the meat adhering to the skins is grated and canned, while the shreds are made into the syrup used in canning the choice disks. The skin refuse is taken back to the pineapple fields and converted into fertilizer—so that, like the pig in the packing-house, every part is utilized.

AN AMAZING MIXTURE OF RACES

Sugar has brought the Islands great wealth, but also the most complicated racial mixtures and problems to be found anywhere in the world.

A visitor to Hawaii in pre-annexation days, before the huge influx of orientals to work the plantations, gives many amusing illustrations of the simple family arrangements of that earlier time.*

"I remonstrated with my sister as to the familiarity of her men servants, but she told me it was the custom of the natives; she had tried to make them say 'Mr.' and 'Mrs.,' but they replied, 'No, no; too many Smith, too many Judd; you John and Lizzie.' One foreign lady, newly arrived, had declared that her servants should never be allowed to address her in so familiar a fashion, and she instructed her husband—she was a bride—never to mention her Christian name in their hearing. One day she had some visitors, and, to their great edification, the cook put his brown head inside the parlor door and asked, 'My love, what vegetable you want to-day?' After that she was content to be simply 'Mary.'"

But the easy ways of that generation were ended by the coming of many thousands of Chinese, Portuguese, Japanese, Koreans, and Filipinos.

* "The Story of Hawaii," by Owen.

Photograph by Joseph F. Rock

THE "FIG LEAF" OF HAWAII: THE APE-APE (SEE PAGES 156 AND 171)

The present population is approximately 41.7 per cent Japanese, 8.6 Chinese, 8.4 Filipino, 14.8 Hawaiian and semi-Hawaiian, 12.4 Latin, which is mainly Portuguese, and 11.8 American, British, Germans, etc. (see diagram, page 139).

Since 1914 the death rate of the pure Hawaiian has exceeded the birth rate, and it is a question of only a few years before this fine old race becomes extinct, except as a mixture with other races.

In recent years increasing numbers of Filipinos have been attracted to the Territory by the big wages paid by the plantations. Among the best of these workers are the Ilocanos, who bring their love of cock-fighting with them. Each Ilocano keeps a pet blooded gamecock, which he grooms and treasures as jealously as any society matron her pet lapdog, and probably the gamecock cost him as fancy a price. When he goes to work he locks his pet in his room as carefully as the housewife locks up her silver, and he lavishes more on his champion's food than on his own.

PICTURE BRIDES

The Japanese long since wisely decided that they would not intermarry with other races; the children of the marriage of a Japanese with a Hawaiian, or with a white, being, in their judgment, inferior to either of the parents.

So when a young Japanese desires a wife and cannot find in Hawaii a girl pleasing to him or willing to marry him, he writes to his relatives in Japan to select a mate for him. Photographs are exchanged and the girl marries him by proxy in Japan, and then starts on the long voyage to Hawaii, where a second ceremony completes the contract. Eleven thousand Japanese in Hawaii have obtained Picture Brides in this romantic method.

A survey of education in Hawaii made under the direction of the U. S. Commissioner of Education in 1919 says:

"With respect to birth and death rates, the Japanese is the most favored race of the Islands, having, among all the races, made the best adjustment to all those conditions affecting race multiplication. . . .

"The Japanese are ambitious to become tenants, to own land, to set up a business, to enter a profession, to rise above the category of unskilled labor, and, as they

individually achieve their ambition, they are, like the Portuguese, participating more and more in the affairs of the Islands, socially, educationally, politically.

"Furthermore, they are all at work; there are few triflers and idlers among them. . . . Their per capita savings bank deposits rank third among those of the island races, being exceeded by the American and Portuguese only. . . .

"All of which can be explained adequately on the basis of the racial qualities inherent in the Japanese, of patience, persistence, thrift, initiative, endurance, ambition, group solidarity, coupled with acumen and astuteness. This group will soon have a majority of the voters of the Islands.

"The fourteenth amendment to the Constitution of the United States declares that every child born within the jurisdiction of the United States is a citizen of the United States. . . . By 1940 about 47 per cent of the electorate may be expected to be composed of voters of this race.

"Whether or not the Japanese desire to achieve political control, without doubt within a few years they will be in a position to do so if they choose." *

The racial situation has been much complicated by foreign-language schools, in which many of the young Japanese have received exclusively Japanese instruction.

* "A Survey of Education in Hawaii," made under the direction of the Commissioner of Education, by Frank F. Bunker, W. W. Kemp, Parke R. Kolbe, and George R. Twiss.

Photograph by Joseph F. Rock

THE FLOWERS AND FRUITING SPIKES OF THE APE-APE

The leaves are not peltate but reniform. In the rain forest along gulches and waterfalls, East Maui, Mt. Haleakala, 4,000-4,500 feet elevation.

AT A NORMAL-SCHOOL DANCE IN HONOLULU

We attended a dance given to the graduating class of the normal school in Honolulu. To us visitors it was a very inspiring example of the beneficial influence of the American public-school system. The bright faces of the decorous

THE RUNNING APPROACH TO THE ANCIENT TOBOGGAN SLIDE SHOWN IN THE PICTURE BELOW

Photographs by Dr. Albert S. Baker

AN ANCIENT TOBOGGAN SLIDE ON THE ISLAND OF HAWAII

Some of these slides were more than a mile long. They were built by the kings, who coasted down on sleds, the slide being covered with dry grass and made slippery with kukui-nut oil.

Photograph by Dr. Albert S. Baker

THE TEMPLE SITE AT NAPOOPOO, HAWAII, WHERE CAPTAIN COOK WAS GIVEN QUARTERS AND WORSHIPED AS A GOD BY THE HAWAIIANS

Only a few yards away he was later killed when the natives, incensed by the harsh conduct of his associates, learned that white men were mortal.

boys and girls revealed as many racial mixtures as the much-discussed photograph on page 136.

We admired especially a young Chinese couple and presently were so fortunate as to be able to converse with them. Both were born in the Territory of Hawaii of Chinese immigrants. She had graduated from the normal school in Honolulu and held a secretarial position in the U. S. customs, the first woman oriental to be employed by the Government, according to her escort.

The eyes of the young man glowed and his chest bulged with pride when he announced that he was an American citizen. He had been to the mainland, as they describe America in Hawaii, for all islanders claim the group to be a part of America, and had studied at the University of Kansas. He asked me to name three of our greatest American college presidents. With considerable hesitation, I volunteered three names. He recognized each instantly, and placed each man correctly.

We also attended an illustrated lecture given for the benefit of the Red Cross by Ex-Governor George R. Carter in a country school house, on the island of Hawaii. Just as one would expect under similar conditions in the United States, the first two rows of benches were packed tight with jolly, mischievous boys of 8 to 12 years of age, but of all racial mixtures. One boy had an expensive electric pocket flash light and, to the admiration and delight of his fellows, occasionally flashed it during the proceedings.

THE GEOGRAPHICAL KEY TO THE PACIFIC

A glance at the map on page 116 will remind the reader of the geographical importance of the Islands. They command every trade route of consequence to China and the Orient across the Pacific. The Islands are in fact the key to the Pacific, a lonely American sentinel on guard for American interests.

Their strategic importance to the United States has been vastly increased by the recent extraordinary improvement of airplanes and airships.

Photograph from E. A. Corey

A PANORAMA OF A SUGAR PLANTATION, SHOWING ON THE LEFT A FLUME IN WHICH SUGAR CANE IS CARRIED BY WATER TO THE MILL WHICH EXTRACTS THE JUICE AND MAKES THE RAW SUGAR

Without reflecting on the oriental elements so predominant numerically in the population of the Islands, I venture to think that it must be apparent to all Americans that the racial situation is so complicated and so uncertain that every military and educational protection should be taken to insure that these Islands, which are so American in tradition and so essential to our safety, remain permanently in our possession.

It would be difficult to overestimate the strategic value of the Territory of Hawaii in the protection of our Western Coast from invasion.

Happily, the treaties drawn by the Washington Conference on the Limitation of Armaments have been ratified by the United States and Japan and the prospect of a war between them we sincerely hope has disappeared.

Before this conference, however, the distrust of each of these countries was plainly leading them toward a struggle which neither of them desired and both of them dreaded; but none the less a struggle for which each felt it must be prepared.

A STRATEGIC STRONGHOLD OF DEFENSE, NOT OFFENSE

The military and naval authorities of the United States had made a careful study of the course such a war would take and of the rôle Hawaii would play.

With an adequate naval base at Pearl Harbor, and the American fleet stationed there, Japan could not make a dangerous assault upon the mainland coast or the Panama Canal. For her navy would have to come nearly six thousand miles from its base, and face the prospect of a stronger fleet between it and home.

On the other hand, Hawaii could not be used as a base of direct attack against Japan by the United States. The distance from Honolulu to Yokohama is 3,400 miles—

RICE FIELDS OF HANAPEPE VALLEY ON KAUAI, THE GARDEN ISLAND

Photograph by Herbert B. Turner

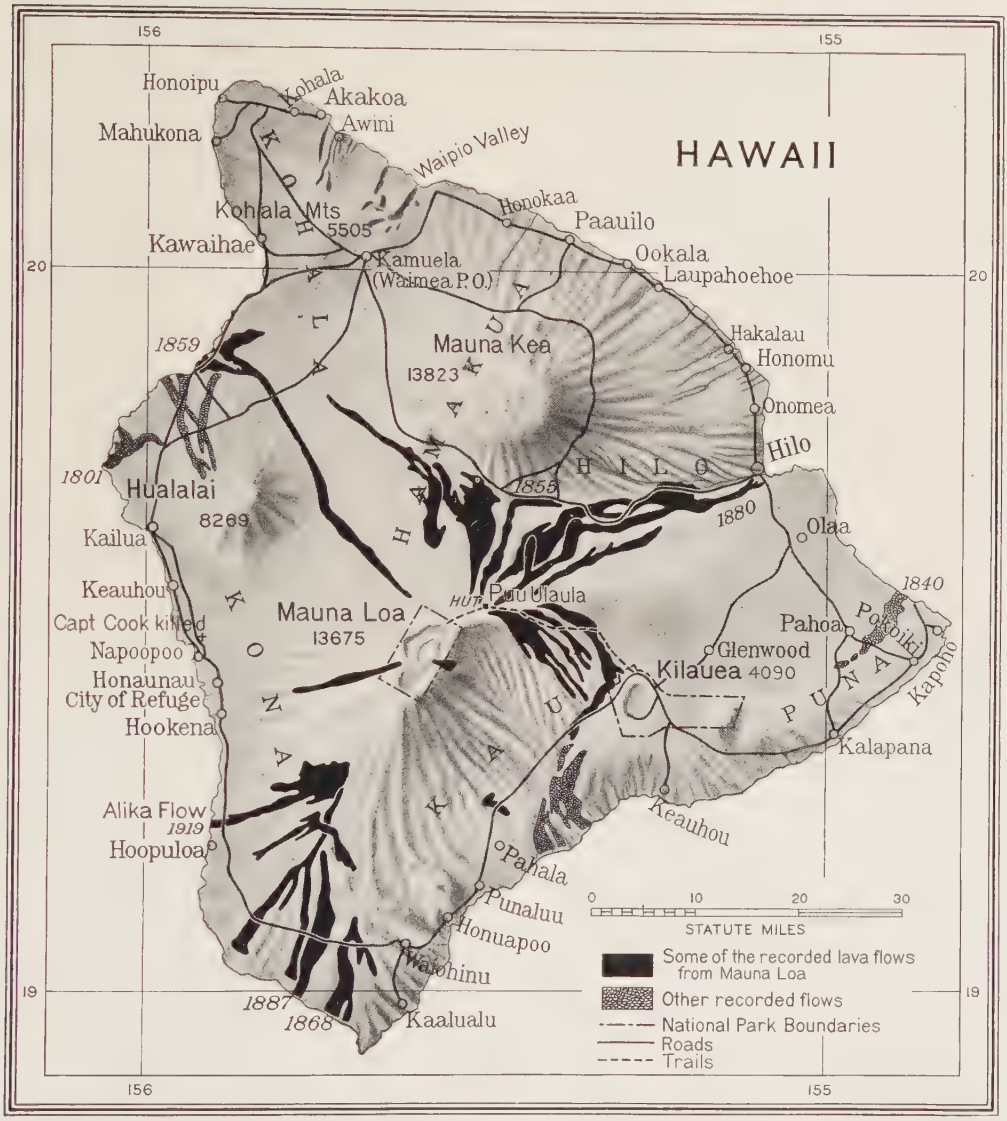
Photograph by Hawaiian Volcano Observatory

A REMARKABLE NIGHT PHOTOGRAPH, SHOWING THE VOLCANOES OF MAUNA LOA AND KILAUEA IN ERUPTION AT THE SAME TIME

The picture was taken after midnight in a 25-minute exposure. Moon on the left. Kilauea lava pit below. Mauna Loa above. The fountains of fire on Mauna Loa are 400-500 feet high. The band of light on Mauna Loa is two miles across.

Photograph by Gilbert Grosvenor

THE RESTHOUSE 10,000 FEET UP MAUNA LOA, IN WHICH TRAVELERS CAN FIND COMFORTABLE BUNKS FOR THE NIGHT



Drawn by A. H. Bumstead

A MAP OF THE ISLAND OF HAWAII, SHOWING THE FOUR VOLCANOES, MAUNA KEA, HUALALAI, MAUNA LOA, AND KILAUEA, WHICH HAVE CREATED THE ISLAND

The map also shows the principal lava flows of recent years. The outpourings from Mauna Loa extend like the arms of an octopus across the entire island (see text, page 237).

so far that even a 5 to 3 navy could not hope to hold the advantage over its less numerous antagonist. The naval authorities of both countries recognize this.

So far from our continental coasts, then, as to be an effective and specific guarantee against attack from the Orient, and at the same time so remote from the Asiatic shores as not to menace them, Hawaii serves an admirable rôle strategically, so long as it is held by our forces, being the impregnable outer defense of our coast line and at the same time not a peace-time menace to any possible enemy.

In outlining the probable course that a war between the United States and Japan would have taken, military and naval authorities believed it would have started with the conquest of Guam by Japan. From there, or simultaneously, the Philippines would have been attacked and must have fallen easy prey.

After that Japan might have settled down to await our attempt at retaking

Photograph by Joseph F. Rock

SUMMIT OF MAUNA LOA (13,675 FEET) ABOVE THE CLOUDS, AS SEEN FROM NEAR THE SUMMIT OF MAUNA KEA (13,823 FEET)

Photograph by R. W. Perkins

A PANORAMA OF THE CRATER OF KILAUEA, SHOWING THE FIERY PIT, OR "HOUSE OF EVERLASTING FIRE" (HALEMAUMAU), IN THE CENTER (SEE COLOR PLATES IV, V, AND VII)

An excellent automobile road approaches close to the rim of the pit.

these possessions, and therein she would have had as much advantage as we would have had should she have attacked our continental territory.

To be assured of holding the Philippines in case of a war with Japan, we would have had to fortify Guam and to make a major naval station there. Yet such a station would menace Japan as much as it would protect the Philippines. It was this knowledge that caused Japanese statesmen to object to the proposed naval base at Guam.

PEARL HARBOR ONE OF THE WORLD'S FINEST NAVAL BASES

Under the naval treaty the naval base at Guam will not be built, and that menace to Japan will disappear. At the same time the treaty leaves both countries free to go as far as they like, the one at Taiwan (Formosa) and the other at Honolulu—each perfecting its powers of defense, but neither increasing its powers of offense against the other's mainland.

Pearl Harbor, which is located some eight miles from Honolulu, is one of the finest natural naval bases in the world. With a depth of over sixty feet, an area of nearly ten square miles, reached by a tortuous channel from the sea, and completely hiding all vessels within its haven from view toward the sea, it leaves nothing to be desired as a natural naval base.

No landing forces on the northeast coast can get across the high mountains of Koolau range, and likewise the Waianae mountains adjacent to the west coast are natural defenses against attack. It remains only, therefore, to defend a short stretch of the northeast coast to protect Pearl Harbor from the rear.

A start has been made in capitalizing its natural strength. A huge dry dock, large enough to float any ship sanctioned by the naval treaty, is in operation, but very little else has been accomplished to insure our permanent possession of this strategic point.

It is both impossible and unnecessary to fortify all the Hawaiian islands—impossible because of their great length of shore line and the wide sea area they cover, and unnecessary because there are no other Hawaiian harbors that would give a hostile navy a foothold from which to defy our fleet.

But the Territory of Hawaii is valuable strategically not only from a military and naval standpoint. It is equally important as an outpost against oriental diseases, many of which would get a foothold on our shores except for the watchfulness of our quarantine officials.

Most of the passengers who travel from the eastern coast of Asia to the west coast of America take passage on ships stopping at Honolulu, where ship and passenger inspection are required before landing privileges can be extended or clearance papers made out. This inspection, after 4,500 knots at sea, reveals the health status on board, and thus Hawaii becomes the health sentinel of America.

Hawaii is also placed strategically in the crossroads of Pacific commerce. Honolulu is the transfer point for the freights of five continents, and the majority of the trans-Pacific lines make it a port of call.

EACH ISLAND OF THE GROUP HAS ITS DISTINCTIVE APPEAL

The visitor to the Territory is continually astonished at the variety and magnificence of scenery afforded by the different islands.

Kauai, called the Garden Island because of the luxuriance of its vegetation, possesses a series of canyons that are remarkable in their splendor of color (see pages 172 and 181, Color Plates II and XIV).

Oahu's loveliness of mountain and forest is supplemented in interest by the many manifestations of the enterprise and inventiveness of the ambitious Americans, which, evident in each of the inhabited islands, are especially impressive here.

The little double island of Maui contains the greatest extinct volcano in the world, Haleakala (see pages 128 and 146-7, Color Plates VIII and IX), gulches overgrown with weird plants (see pages 156 and 171), a canyon known as the Iao Valley (page 170), which is very reminiscent of our magnificent Yosemite, and sea drives that in color of cliffs and dazzling waters remind one of the Amalfi coast of Italy.

The largest island, Hawaii, has the distinction of possessing the only active volcanoes of the group—the red lake of Kilauea, easily accessible by automobile

Photograph by Hawaiian Volcano Observatory

THE BOILING LAVA HAS OVERFLOWED AND BLOCKED THE ROAD NEAR THE FIERY PIT, THE WALLS OF WHICH MAY BE DISCERNED IN THE DISTANCE: KILAUEA

Photograph by Hawaiian Volcano Observatory

A PARTY OF TOURISTS EXAMINING A RECENT MILD OVERFLOW FROM THE BOILING LAKE, WHICH IN ITS METALLIC LUSTER RESEMBLES A VAST BED OF COAL

While still warm, it is perfectly safe to traverse.

Photograph by Gilbert Grosvenor

TRAVERSING THE DESERT OF AA LAVA WHICH COVERS THE UPPER SLOPES OF LOA AND RESEMBLES A LIMITLESS SLAG HEAP

In the distance the fume cloud from Kilauea Volcano may be seen. Kilauea is a great pit on a rolling plain; it has not the slightest resemblance to a mountain. Great clouds of sulphurous vapor roll incessantly upward from the pit. As twilight deepened into the darkness of night, the column of cloud glowed from the furnace beneath like a great pillar of fire (see pages 184, 186, and 187).

road to its brink, and Mauna Loa, the world's greatest active volcano.

The naturalist and student can find occupation and enjoyment for a lifetime in investigating and collecting land shells (see Color Plate XII), the incomparable wealth of endemic plants, and Hawaiian folklore.

The tiny islands at the extreme western end of the Territory form the Hawaiian Bird Reservation. Of these Laysan supports the most interesting bird colony in the world (see pages 123, 151, and 152).

To this bit of sandy beach, scarcely two and one-half miles long and one mile wide, millions of birds of many species resort every winter season. So crowded are they that some find it necessary to burrow underground to find a place to lay their eggs.

When we think of the long journey that these birds make twice each year over the three thousand miles of ocean without a rest, the wonder is that they do not perish on the way.

* "Just why the plover and all the other migratory birds undertake these wearisome flights across the wild open ocean it seems must ever remain a mystery. Without doubt, when storms are encountered many must lose their way and go down to watery graves, or, thrown from their course, must fly for days over the great dull expanse in search of land. Perhaps it was in some such accidental way that the first plover happened to visit Hawaii in the long ago.

OLD "STUMP-LEG"

"It is interesting to know that once the journey is successfully made, barring accident, the voyager is able ever afterwards to make the passage with unerring accuracy. An interesting case in point is the record I secured from Mr. Max Schlemmer, who for several years was the manager of the colony of laborers formerly stationed on Laysan.

"On one occasion a fine male bird, that was in the habit of roosting every night on a little mound of sand a few rods from the door of the manager's house, attracted his attention as it fluttered about on the sand apparently unable to fly.

"Picking it up, it was found that it had broken its leg and was in a pitiable condition. The manager amputated the leg at the fracture and set the bird at liberty. To the surprise of all, it healed perfectly.

"The stump-leg furnished a mark for identification that served to distinguish the bird from its fellows, and it naturally became an object of interest in the colony. It remained about the island all winter, returning each night to its favorite roosting-place on the sand mound. It became unusually tame and fearless.

"When spring came, however, it responded to the most powerful call that stirs the avian brain, the homing instinct, and with its fellows left the wave-washed shores of Laysan to make the long flight back from whence they came, seemingly for no more intelligible reason than that they had made the journey before.

"Naturally, the manager bade good-by forever, as he thought, to his bird neighbor the first night it failed to return to its roost. But, being a seafaring man, and accustomed to the excellent discipline of keeping a ship's log-book, whether on land or sea, he accordingly made a note of the fact with day and date and dismissed the incident from his mind.

"The summer passed, and one early autumn day the whole colony was thrown into a state of excitement by the announcement that the stump-leg plover had returned the night before and had been found that morning occupying his sand-pile roost. The bird was apparently as much at home as though a summer cruise to some distant land was a regular occurrence and a matter of little consequence.

"Naturally, so important an event as the return of the stump-leg plover to its winter home was made a matter of record in the log for the day.

"The bird more than ever became the object of interest and concern on the part of all hands, for had he not accomplished a feat entitling him to the highest respect among seafaring men? Had not this bird, without a chart or compass, started from a given point in the very middle of the Pacific Ocean, and made a cruise extending over several months, and at least 6,000 miles of trackless water, returned again, arriving by night at the very point of starting? Certainly old 'Stump-leg'

* From "Natural History of Hawaii," by William Alanson Bryan.

was an able seaman and a master navigator.

"But this remarkable record does not stop with the report of the single trip. The log-book records that, for five years, each fall this bird returned to Laysan, arriving each year at almost the same date and departing in the spring with equal punctuality for parts unknown.

"But, at last, 'Stump-leg' failed to return. Whether he was killed by hunters in Alaska or gave out on the weary and dangerous journey, or lost his bearing and went down struggling against fate, or died a natural death, will never be known; but certain it is that his voyage to and from Laysan Island and the records made of them constitute a most interesting and valuable incident, throwing much light on the unerring accuracy of the mysterious instinct which, doubtless through hundreds and perhaps thousands of generations, has served to guide our feathered friends in their migrations to and from Hawaii."

All the larger islands of the Territory possess numerous remains of ancient Hawaiian temples (see page 179), fish ponds of unprecedented size and cleverness of construction (see pages 122 and 146), and curious artificial slides that were used in former days for a sport which was popular with all classes, called summer tobogganing (see page 178).

"It consisted in sliding down hill over carefully prepared slides, a few yards in width, on a long double-runner sled," writes W. A. Bryan in his "Natural History of Hawaii." "Any smooth mountain slope of sufficient steepness would serve the purpose.

"The only complete sled in existence is in the Bishop Museum. The two runners of this one are each just over eleven feet in length and are three inches apart. They are firmly fastened to the narrow frame. The native tobogganer would lie flat upon this curious sled, the *papa holua,* and give it a push with his foot, to start it off.

"During the descent it would frequently gain an immense velocity, and the sport, while exhilarating, must have been accompanied with great danger to life and limb. Several of the old slides are more than a half mile in length; one on the town side of Diamond Head ran far out on the plain, and another still longer one is to be seen from King street, at the opposite end of the city of Honolulu."

"The goddess of the volcano, Pele, was supposed to delight in these contests, coming disguised in some earthly form," says G. W. Browne.* "As may be imagined, she always became a dangerous rival.

"Kahavari, a Hawaiian prince, once raced with her when she was impersonating a beautiful young woman. On the first trip he outdistanced her, and when she asked for a second trial, claiming that her sled was inferior to his, he laughed at her and started alone down the descent.

"Hearing wild shouts and great confusion, he saw that she was pursuing him, riding on the crest of a lava wave. In his desperation he fled for the sea, where she could not follow him. But she threw stones after him, making the water so hot he perished. To him who doubts this tale the stones are pointed out on the beach, and the track of the lava stream is shown."

Fortunately, another exciting sport, surf-riding, was revived, before it had become a lost art, by Alexander Hume Ford, the Director of the Pan-Pacific Union of Honolulu, and is now the pastime of many hundreds of young people of all races living in the Territory.

"WHERE ARE THE VOLCANOES?"

Where are the volcanoes? is the first question that every visitor asks as soon as he lands at Honolulu, for the fact that in the Hawaiian Islands we may see the world in the making has been well and successfully advertised.

Shells of dead craters mark the Islands everywhere. Diamond Head, and the Punch Bowl, in the city itself, are perfect tufa cones formed in eruptions which occurred many millennia ago and probably lasted only a few minutes. But the most interesting volcanic creations are on the islands of Maui and Hawaii, included in the Hawaii National Park and accessible by a short voyage from Honolulu (see map, page 123).

After a horseback excursion to Iao Valley (page 170) and lunch in the tropical garden at Wailuku, Maui, on mangoes,

* "The Paradise of the Pacific," by G. Waldo Browne.

Courtesy of the Bishop Museum

A HAWAIIAN CHIEFTAIN OF THE OLD DAYS WEARING COSTLY ROBES OF FEATHERS AND FEATHER HELMET, AND CARRYING A KAHILI, OR FLY-FLAP, ALSO MADE OF FEATHERS

(Note the anklet of sharks' teeth.)

Photograph by Joseph F. Rock

WAIMEA CANYON ON THE ISLAND OF KAUAI

It is amazing to find on a small island in the mid-Pacific this miniature of our Grand Canyon of the Colorado. It is more than one-half mile deep, and in the brilliancy of its colored walls and majesty of proportions delights the seeker for Nature's masterpieces.

Courtesy of the Bishop Museum

THE QUEEN'S MANTLE—THE FEATHER CLOAK OF KIWALAO

To make these regal robes of the ancient Hawaiians many hands working for generations were required. The "million-dollar" cloak in the Bishop Museum at Honolulu was more than 100 years in the making, and is probably the most precious garment in any museum. Only two feathers from each wing of the mamo, a rare bird, had the requisite color, texture, and length for the royal cloak.

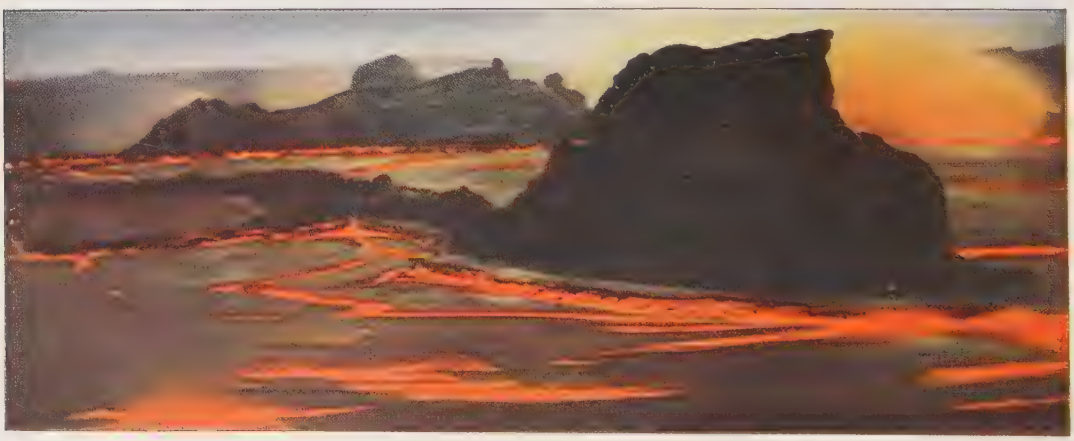
Photographs from The Volcano Research Association

GAZING INTO THE PIT OF EVERLASTING FIRE: HALEMAUMAU, KILAUEA

The fiery lake is in a state of constant ebullition. The red-hot mass of liquid rock seethes and boils like soup in a gigantic kettle.

A GIANT FOUNTAIN OF FLAME IN THE FIERY LAKE

An angry mass of molten lava has leaped 50 feet in the air and is plunging down with a terrific splashing that reverberates like thunder.



A VIEW OF THE LAKE, SHOWING SEVERAL OF THE ISLANDS, OR CRAGS

which dot its surface, and also the dark scum which covers it, like the scum on a cup of boiling milk or cocoa.

Photographs from The Volcano Research Association

A ROW OF FOUNTAINS PLAYING IN A TUNNEL BENEATH ONE OF THE CRAGS OUT IN THE LAKE

In the background can be seen the summits of similar fountains, the picture having been taken just as darkness settled down. Note the reflection of light upon the molten lava.

RAVENOUS BILLOWS OF LAVA UNDERMINING CLIFFS OF ADAMANTINE ROCK

When the walls topple the bystander is amazed to see these great masses melt in the brimstone lake like lumps of butter on a hot frying-pan, while the escaping gases hiss fiendishly.

A RIVER OF FIRE: HAWAII NATIONAL PARK

Red-hot lava which has overflowed the crater rim of Halemaumau and is rushing madly onward at a speed of 15 miles per hour.

A DYING CONE WHICH HAS EMITTED A FLOW OF LAVA AS BLACK AS INK ON THE SLOPES OF MAUNA LOA

A CLOSE VIEW OF THE FIERY LAKE, HALEMAUMAU, KILAUEA

"The sight was magnificent and worth a voyage round the world to witness," wrote Admiral Charles Wilkes in the [illegible]

From a photograph by Gilbert Grosvenor

ENTERING THE WORLD'S VASTEST EXTINCT CRATER, HALEAKALA, ON THE ISLAND OF MAUI

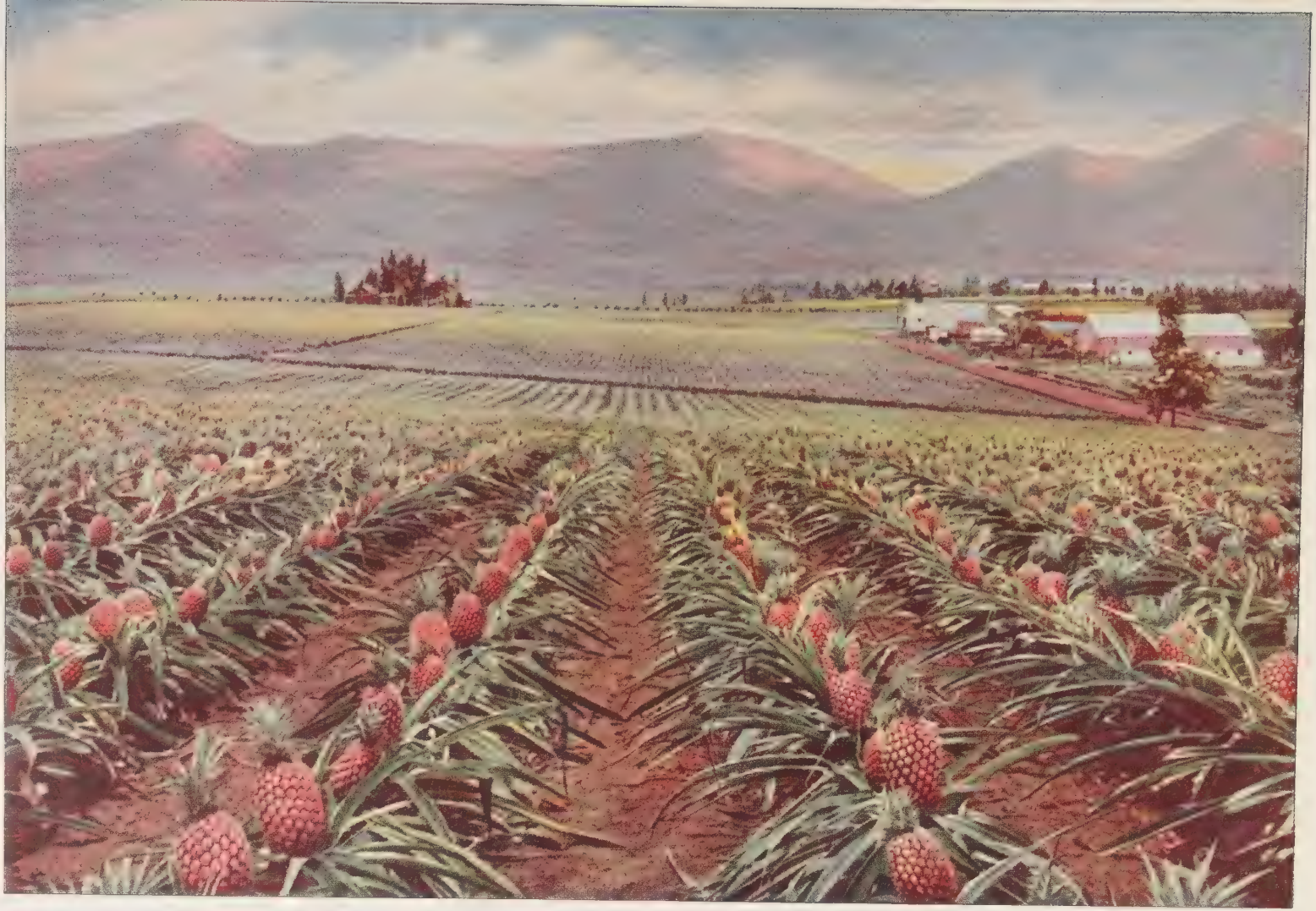
All Manhattan Island could be buried in this gigantic hole, which is 20 miles in circumference and more than one-half mile deep.

From a photograph by Gilbert Grosvenor

TWO OF THE SIXTEEN GORGEOUSLY COLORED DEAD CONES, VARYING FROM 600 TO 1000 FEET IN HEIGHT
which dot the floor of Haleakala Crater and are mute evidences of its former fires. Hawaii National Park.

From a photograph by R. K. Bonine

RIDING THE SURF AT WAIKIKI, HONOLULU



A FIELD OF PINEAPPLES ON THE ISLAND OF OAHU

From a photograph by R. K. Bonine

From a collection by Dr. H. A. Pilsbry

TREE SHELLS (*ACHATINELLA*) OF THE HAWAIIAN ISLANDS

These snails live on the bark and leaves of trees and shrubs in the rain-forest of the mountains overlooking Honolulu. They subsist on minute fungi. In certain localities they are as plentiful as blueberries on North American barrens. Nowhere else in the world can such richly colored land shells be found, which are survivors from a very ancient geological era.

From an autochrome by Charles G. Heiser

BOUGAINVILLÆA-BOWERED ST. CLEMENS CHURCH, HONOLULU

From a photograph by Gilbert Grosvenor

THE FLAME TREE, OR *POINCIANA REGIA,* IN THE GARDEN OF WILLIAM R. CASTLE

a missionary's son born in Honolulu and one of the twelve Americans who overthrew the monarchy and proclaimed the republic.

From a photograph by R. E. Baker

HANALEI BAY, ISLAND OF KAUAI, ONE OF THE SCENES WHICH HAS WON FOR THE HAWAIIAN ISLANDS THE NAME "PARADISE OF THE PACIFIC"

AS DIES THE DAY IN HILO, ISLAND OF HAWAII

From a photograph by Henry W. Henshaw

© Arthur W. Rice

FISHING AT NIGHT IN HAWAIIAN ISLANDS

avocado, and breadfruit, swiftly by automobile we ascend from rice and sugarcane fields to acres that shipped wheat, potatoes, and corn to California in the Gold Rush of '49, proceeding from the tropics to the temperate zone in less than an hour.

THE HOUSE OF THE SUN ON MAUI

From Olinda, about 4,000 feet up on the flank of Haleakala, we took horses to the edge of the mammoth crater, which is so colossal that it is called the House of the Sun by the Hawaiians.

In four hours we had mounted from sea level to far above the clouds. Here at an elevation of nearly two miles we found a large stone house with room enough for twenty people to bunk comfortably.

Few mountain tops even in populous regions can evidence so successful an effort on the part of the community to make its natural advantages available to all. But no one familiar with Maui's history is surprised.

On this island the first newspaper in Hawaii was printed, in 1834, at the Lahainaluna Seminary. This school was one of the first in the New World to undertake manual training, and its success in teaching the practical arts inspired General Armstrong, who was born on this island, to found the Hampton Institute for American Negroes and Indians.

The panorama of cloud and mountain and valley and the glories of sunrise and sunset from the Haleakala crater rim have been described by Mark Twain and many gifted writers who have journeyed from every land to see this view (see pictures, pages 128, 146, 147, 226, and 227).

In succeeding days we descended into the vast crater abyss (see Color Plates VIII and IX), traversed its length, scrambled down the precipitous south flank to Kaupo (see map, page 145), and continued by a narrow paved trail built by some Hawaiian prince in prehistoric days to Kipahulu and Hana. Thence we proceeded by the famous Ditch Trail, past innumerable lovely waterfalls, some of them with drops of hundreds of feet, back to Haiku and Paia.

Our host and companion was a substantial banker and pineapple grower who had come to the Islands from the mainland as a young man and succeeded. His wife was a descendant of a missionary of the Second Company, which means that he was a member of the second shipload of missionaries.

The son, with thousands of others from the Territory, had served in the U. S. Army during the World War. He had been detailed to the Tank Corps and seen very rough service in France. On two successive days his companion in his tank had been shot to pieces and the tank obliterated, but he had escaped without a scratch.

A WOMAN'S TERRIBLE EXPERIENCE IN TIDAL WAVES

Hilo, the capital of the island of Hawaii, is an enchanting little city of about 10,000. It stretches along the bay of the same name, and is enveloped in waving coconuts and vegetation so luxuriant that it is almost hidden from the water. Situated on the slopes of the two active volcanoes of Kilauea and Mauna Loa, its location may be likened to a seat on a rocking chair which is rocked by the throbbing of these two Titans alternately.

There are records of as many as 70 shocks daily for one month, but the people of Hilo do not seem to mind them.

The quakes, most of them imperceptible, are not dangerous, nor are the outbursts from the volcanoes. During the more than 100 years since the missionaries landed, there has not been a single death in the Territory caused by a volcanic eruption.

The same cannot be said of the tidal waves that have raged against all the shores of the island and at times brought great destruction.

Many are the tales told.

Our hosts on a motor trip to Kalapana with their two young sons had been camping for the night on the south shore of Hawaii some months previous to our visit. In the morning the Judge was already at the wheel of the automobile which they had parked on the small wharf, and the others were standing on the pier preparing to get into the machine, when one of the boys looking toward the sea shouted, "See the great wave!" They

Photograph by Gilbert Grosvenor

THE SURFACE OF MAUNA LOA IS PIMPLED WITH MANY HUNDREDS, PROBABLY THOUSANDS, OF DEAD CONES FROM WHICH MORE OR LESS RECENTLY HAVE SPEWED GREAT QUANTITIES OF MOLTEN ROCK, AS ON PAGES 217-219

This picture was taken above the clouds, elevation 10,500 feet, near the resthouse.

Photograph by Gilbert Grosvenor

A LANDSCAPE ON THE SLOPES OF THE WORLD'S GREATEST BUILDER—MAUNA LOA VOLCANO

On the left may be seen the bed of the channel in which a torrent of lava from the cone has recently poured down. In traversing this region of sharp clinkers and powdered glass the mules sink repeatedly above the knees, thus explaining the reluctance of the ranchers to rent their animals for such expeditions.

Photograph by Gilbert Grosvenor

CROSSING A REGION OF PAHOEHOE, OR SATIN ROCK, WHICH CRUNCHES UNDER FOOT LIKE THE FROZEN CRUST OF A SNOW FIELD AND SPARKLES WITH THE RADIANCE OF JEWELS. ELEVATION ABOUT 11,000 FEET (SEE PAGES 235-236)

Along the skyline of Mauna Kea, whose bulk towers dimly in the distance, I counted 157 cones—only a fraction of the number that spotted its surface.

Photograph by Frank C. Atherton

MRS. GROSVENOR LOOKING DOWN INTO THE CRATER OF MAUNA LOA, 13,675 FEET, NOW QUIET AND NOT RECOGNIZABLE AS THE FURIOUS CALDRON WHICH WAS BELCHING FIRE AND LAVA A FEW MONTHS PREVIOUS (SEE PAGES 213 AND 236)

Photograph by C. E. Nutting

A VIEW OF EXTRAORDINARY ACTIVITY IN THE PIT OF KILAUEA

The picture was taken within 300 feet of the rim of the crater, when it seemed that the heat above and the opening fissures beneath would consume and swallow photographer, friends, and films (see also Color Plates, IV, V, and VII).

turned and beheld an enormous wall of water rushing toward them.

There was not time to flee before the tidal wave engulfed them.

The wave swept the wharf clean of a great pile of barrels and lumber, and as it receded bore the Judge's wife half a mile back into the ocean. She was an able swimmer, so felt no alarm at getting wet, but was nervous about the numerous sharks that had been lured into these waters by great quantities of dead fish which had been killed by hot lava pouring into the sea from the Alika flow (see page 160). She had nearly regained the shore when another wave carried her back, and this experience was repeated five times before she was rescued by her husband.

As the Judge is a man of very positive opinions, with the habit of expressing them, when the local paper that afternoon got out an extra, with great headlines reaching across the page, "Carlsmiths swept out to ocean by tidal wave," it is said some malefactors sighed with relief, until they read in small letters further down "and brought back again."

The tidal wave which overwhelmed our friends was probably caused by a sudden flow of lava through a subterranean passage into the sea.

The island of Hawaii is actually at the present time being built up from the ocean. Considerable portions of it are still so new that the glass ejected by the volcanoes to form the new land has not yet had time to disintegrate, and often the automobile road is composed of powdered glass compressed until it is compact. When the sun's rays strike it aslant, the road gleams.

Though called a mountain, Kilauea Volcano has not the slightest resemblance to a mountain, being a great cup-like depression in an extensive plain. In the center of this depression there is a deep throat in which red-hot lava rises and falls like the mercury in a thermometer. No words can describe the fury of this raging, billowy red lake, but the pictures (Color Plates IV, V, VII, and pages 184,

229, 230, 231, and 232) will convey some conception of its impressiveness.

OBSERVATORY PERCHED ON VOLCANO'S RIM

Perched on the edge of the volcano is the laboratory and home of Dr. Thomas A. Jaggar, who for 15 years has been the Director of the Hawaiian Volcano Observatory, maintained by public-spirited citizens of Honolulu. This observatory is the famous center of the important new science of vulcanology, the study of volcanoes and earthquakes, in which Dr. Jaggar is one of the pioneers.

Forewarned of prospective eruptions by the earthquake tremors which his instruments record, Dr. Jaggar is ready, as soon as a new building operation is initiated by a volcano, to proceed to the locality and record in photograph and notebook every stage of construction.

Thus he secured a complete photographic history of the Alika river erupting from the flank of Mauna Loa in 1919, one of the tremendous lava flows of the century (see pages 160, 216-224).

He tells of his visit to the scene of greatest volcanic activity in a dramatic report:*

"The horses were left at a high flow of brown block lava, and the walk to the source fountains was across some ten alternations of AA and pahoehoe" (see picture, page 235). "Here could be seen the line of rift cones, some forty cones visible at one time, a true fissure eruption, along a crack" (see page 216).

"Great fountains were spouting continuously along the fissure for a thousand feet, like a wall of red flames, and in detail they were seen to be made of incandescent, light crumbly material, yellow when it shot up and red when it came down.

"The noise was a roar like surf on the rocks, and was occasioned by gas rushing through a lava pool filling the rift, churning it to a foam, and flinging up the foamy matter to solidify as it fell. . . .

"We proceeded across much-faulted ground to the immediate base of the rampart built by the fountains and hemming in the eastern margin of the great lava lake. . . .

* From Monthly Bulletin of the Hawaiian Volcano Observatory, Vol. VII, No. 10.

Photograph by Hawaiian Volcano Observatory

MAUNA LOA SIGNALING THAT IT IS ABOUT TO RESUME BUILDING OPERATIONS

Activity of this violence in the crater is usually a portent that a rift soon will open on the flanks of the mountain and a river of lava begin to flow. The column of lava fume and flame is 10,000 feet high.

THE FIRST STAGE—A SUDDEN RIFT, PROBABLY CAUSED BY THE SURGINGS OF THE LAVA IMPRISONED BENEATH THE CRUST, AND ATTENDED BY EARTHQUAKES

Shortly after the photograph was taken, lava poured forth in the manner shown in the picture below.

Photographs by Hawaiian Volcano Observatory

THE SECOND STAGE—"ARTESIAN" WELL OF RED, MOLTEN LAVA SPOUTING UP FROM THE GROUND

Photograph by Magoon

A SPOUTING CONE AT THE SOURCE OF THE ALIKA FLOW, MAUNA LOA, VOMITING MOLTEN ROCK, BLOOD-RED BUT FLUID AS WATER

"The ridge where we stood was 50 feet above the old ground level, and 50 yards north of us stood the highest peak of the rampart wall, a singular structure when seen end on. It stood up as a narrow slab or shell confining the mighty fountains, and its height above the outside ground was about 100 feet" (see page 217).

"Next to it the fountain jets sprayed up continuously half again as high, the glowing soft fragments eternally pounding down upon the rampart, plastering it with the new matter or rolling noisily down the outer slope, gilded with a mottled fiery pattern. . . .

WHERE THE LAVA FLOW PLUNGED INTO THE SEA

"Through the southwestern wall the lake had found an outlet, and here, in a gorge 40 feet wide, rushed the main lava flow, like the sluiceway of a dam. This flow, only 100 feet west of us, made a fiery river, with current estimated eighteen miles per hour. . . . The stream appeared shallow, with many standing waves and bright grottoes along its banks.

A FOUNTAINING CONE AT THE SOURCE OF THE ALIKA FLOW, MAUNA LOA: DAY SCENE

In the foreground is an old Hawaiian altar, where human sacrifices were made to the volcano goddess in ancient times.

Photographs by Hawaiian Volcano Observatory

EARLIER STAGES IN THE ALIKA FLOW: ALONG A CRACK EXTENDING SEVERAL MILES WHICH HAD SUDDENLY APPEARED ON THE SLOPES OF MAUNA LOA, JETS OF LAVA AND VAPORS ARE POURING (SEE TEXT, PAGE 213)

Photograph by Hawaiian Volcano Observatory

THE BATTERY OF 200-FOOT LAVA FOUNTAINS FORMING A BARRAGE HALF A MILE LONG; BY DAY: ALIKA CONES, MAUNA LOA (SEE ALSO PAGE 219)

Photograph by Hawaiian Volcano Observatory

ACTIVE CONES AT THE SOURCE OF ALIKA FLOW, MAUNA LOA, 7,000 FEET ABOVE SEA-LEVEL (NIGHT SCENE)

The flow is pouring out of the cone in the foreground.

Photograph by Hawaiian Volcano Observatory

A BATTERY OF 200-FOOT FOUNTAINS BY NIGHT: ALIKA CONES, MAUNA LOA (SEE ALSO PAGE 217)

What causes these terrific manifestations of Pluto's power? Science cannot answer.

"The writer obtained one glimpse of the lake surface by climbing the rampart at the northeast end, where the summit was only 40 feet high and the fountaining less violent than at the south. The heat was intolerable, but by choosing a moment when the falling of fragments was at a minimum, it was possible to scramble to the edge, look in, and then beat a quick retreat. A definite lake surface of heaving, foamy lava lay about 20 feet below the edge. . . . It was at this lake that the Alika flow took its rise. . . .

"The stream plunged into the sea at the Alika shore over an older flow of the same sort fourteen miles from the source rift.

"The stream continued to flow as a lava river for ten days.

LIGHTNINGS FLASHED IN STEAM COLUMNS

"The uprush of steam where the lava made contact with the sea" (see page 160) "carried up rock fragments and sand and built a black sand cone" (see page 223). . . . "Lightnings were seen in the steam column. There was much muddying of the water and fish were killed in considerable number. . . .

"Great raft blocks of lava, red hot or black or red below and black above, rode along with the current, either smoothly or rolling over, as though striking on the bottom (see page 235).

"The color effects at sundown at the rift source on Mauna Loa were gorgeous beyond description. Over the scarlet fountains rose the sheets of red and green flame topped with lilac fume, against a murky green or blue-gray background. Above rose the great buff-colored volutes of cloud, with individual billows coffee-colored or brown. All of this was backed by an outer sky of deepest cobalt blue, with normal distant horizon clouds of pearly gray."

A week later, on his second expedition to the source rift of the Alika flow, Dr. Jaggar was accompanied by Mrs. Jaggar, Dr. and Mrs. J. R. Judd, and guides.

"The fountaining and overflow at the middle group of cones by this time had vastly increased, and the noise had changed from a mild roar, like the surf on a rocky coast, to a loud, thunderous pounding. . . .

"The middle fountains increased in violence and height until the whole series of vents there became one gigantic line of geysers, with maximum jets estimated 500 feet high, at about 4 a. m., October 10.

"About 9 p. m., in order to collect gas, I took vacuum tubes of 300 cubic centimeters' capacity, and on attempting to reach the live flames of the northern cones found it necessary to cross to leeward of fresh flows making gas and heat which were both insupportable.

"The gas was quite different from the smoke of the south rampart, which had been suffocating in volume, but still somewhat tolerable with the aid of a wet cloth over the nostrils. The northern gases were not visible; they had no odor except the foundry smell, but they corroded the eye tissues and gripped the lungs so as instantaneously to stop all breathing. A wet cloth produced no improvement whatever, and there was no possibility of crossing this gas belt and surviving, unless with an oxygen helmet."

As the great anxiety of the South Kona ranchers continued unrelieved by any complete information as to what was transpiring on the mountain above them, Dr. Jaggar and Dr. Judd organized a third expedition.

"On the morning of October 25 an excursion was made around to the east side of the rift line in order to compare conditions with what had been observed in the earlier stages of the eruption. The rift line is a distinct single crack trending south-southwest and the big cone craters are developments due to lava and gas rising through this crack.

"This development began with the southern, or Alika, cone, and in the course of a month has deserted that end and built up the northern cone a half mile away.

"The line of cones was now a high ridge, rising in places 200 feet above the surrounding country, banked up by flows and pumice for nearly half this height, the three main eminences of the ridge being big horseshoe cones north, south, and in the middle, the southern one dead, the other two alive, and the northern one roaring, fountaining, and flowing continuously. . . .

"Over the high summit lip the fountains would fling their red, crumbly fragments, which poured down in an endless

Photograph by Hawaiian Volcano Observatory

PROFESSOR JAGGAR'S MASTERPIECE: A LAVA FOUNTAIN 200 FEET HIGH, PHOTOGRAPHED AT A DISTANCE OF ONLY A FEW FEET; MAUNA LOA

(SEE PAGE 224)

Photograph by Morihiro

ALIKA LAVA FLOW POURING IN A CHANNEL DOWN A HILLSIDE, AMID FIELDS OF ITS OWN SUBSTANCE. THIS SLOPE OF MAUNA LOA WAS FORMERLY COVERED BY A DENSE FOREST (SEE PAGE 160)

Photograph by Hawaiian Volcano Observatory

THE ALIKA FLOW, MAUNA LOA, WHERE IT ENTERED THE OCEAN (SEE PAGE 160)

The last flow was very sluggish and went directly through the sand piles which had been thrown up by the lava exploding as it reached the ocean in the earlier stages of the flow.

avalanche of fire on the steep outer slope. The wind on this hot surface set up small tornadoes lasting several minutes, moving along the slope and picking up the light pumice in violent, noisy whirls.

"Taking advantage of the long low spur on the north side, I climbed that slope in order to get an instantaneous photograph of the fountain by as close an approach as possible. It was necessary to clamber up through pumice knee-deep and excessively hot.

"On the other side of the spur, which was the east end of the inclosing horseshoe ridge, lay the fountaining basin, with its gigantic waves surging forward to the cascade outlet, and from under the back wall of this cup rose the geyser of fiery fragments 200 feet above the level of the top of the spur, the pieces bright red hot and very porous, from six inches to four feet in diameter.

"It was evident from occasional fragments on the ground still glowing, and from the incessant change of direction of the jets, that the nozzle might at any moment be turned in my direction, so that it required quick work to get to the summit of the spur, point and snap the camera, and get away without being bombarded" (see page 221).

"The sensation of incessantly looking up at that towering curve of rising and falling bombs and calculating its angle, with the heat almost insupportable and the noise deafening, was an experience not soon to be forgotten.

"I succeeded, however, in getting to the edge of the inner declivity and taking a look down into the basin, as I pointed the lens and discharged the shutter. It all had to be done in much less time than it takes to tell it, for a very few seconds of the heat would have ruined the camera. The far wall of the basin made a reflector for the heat; so that, but for the wind at my back, it is doubtful whether I could have reached the edge at all.

"The interior of the basin was like a titanic open chalice of fiery liquor foaming in scarlet surges, these being impelled continuously forward by the geyser jets behind, the flood lifted by the jets losing its liquid aspect almost instantly, the expanding gas within the jet giving it the appearance of very loosely knitted worsted.

"The frothing surges were quite as liquid in appearance as any beaten foam and the mass bubbled and seethed, quickly quieting down to form black skins where the pond cascaded through the sluiceway leading to the flow channel. The nearest falling fragments at the moment of taking the picture were apparently 50 feet away."

THE ASCENT OF MAUNA LOA

We tarried several days around Kilauea, fascinated by the many varied manifestations of Pluto's power (see Color Plates IV, V, VII) and enjoying the refreshing fern forests (see page 164); but ever on the horizon, dominating every view, towered the huge, challenging bulk of Mauna Loa. Having read the descriptions of its ascent by Admiral Wilkes, Titus Coan, and Professor Jaggar, which are among the epics of geographic literature, we were determined to make the personal acquaintance of the greatest architect, contractor, and builder on our planet.

As a half-way house had been constructed at 10,500 feet and an admirable trail broken to the summit by a company of American soldiers by direction of Major-General W. H. Carter, when he was commander of the Department of Hawaii, all that was required for the ascent to the crater was the ability to endure three days in the saddle, immunity from mountain sickness, and, most important, sufficient eloquence to persuade a rancher to hire out his mules. In this last particular we received assistance from Professor Jaggar; seven mules and two guides were secured and we were off.

Our trail was fairly even and the grade of ascent so gradual as to be almost imperceptible. No chasms or ravines interrupted our progress, as on the older islands, their absence attesting the youth of this part of the mountain.

A FRIGHTFUL DESERT ABOVE 8,000 FEET

Several miles out we passed through a forest of giant koa (see page 144), some of which have straight trunks running up 50 feet without a limb.

The vegetation soon became sparse, and then the last vestige of green disappeared. Mauna Loa above 8,000 feet proved to be a frightful desert, at once "the creation and the prey of the mightiest force on earth."

This desert is composed of a great sea

Official photograph, U. S. Army Air Service, Photographic Section

THE NEW AVIATION FIELD AT KAHULUI, ON THE ISLAND OF MAUI

Forced landings in the channels between the Hawaiian Islands are not a joyous thing to contemplate; for, as the sea is very rough, a plane would last but a short time in the high waves, and incidents such as tiger sharks are not pleasing to contemplate. On the expedition which resulted in these photographs the squadron of four planes guarded against mishap by flying across the channels only in formation, one ship carrying radio, so that in case of motor failure this plane could remain near the fallen plane while a third plane could return for help.

This and the succeeding seven illustrations (pages 226 to 232, inclusive) were made from photographs taken by Lieutenant A. C. Wriston, commanding the 11th Photographic Section, and his assistant, Sergeant Richard L. Agnew. The photographs were made for scientific purposes, at the suggestion of the National Geographic Society, and were taken, in the course of mapping, by aërial photography, all harbors in the Hawaiian Islands, which survey had been ordered by Major General

Official photograph, U. S. Army Air Service, Photographic Section

A SEA OF CLOUDS CREEPING IN TO THE EAST, WHERE THE WHOLE SIDE OF HALEAKALA VOLCANO, ON THE ISLAND OF MAUI, HAD BEEN BLOWN AWAY. PHOTOGRAPH TAKEN FROM AN ELEVATION OF 11,000 FEET (SEE PAGES 128, 147, 207)

"We climbed steadily, dodging clouds, until we finally left them below us. Ahead stretched an unbroken sea of clouds, with Haleakala, a magnificent island, rising through them. Breasting the southern shoulder, we got our first glimpse of the immense crater, theater of vast volcanic action in the long-forgotten ages. Within the crater could be seen many smaller cones or craters, all good-sized hills, and between them the lava flows, distinguishable by their variation in color as the work of different ages."—LIEUTENANT R. C. WRISTON.

Official photograph, U. S. Army Air Service, Photographic Section

THE IAO VALLEY AND KAHULUI, ISLAND OF MAUI, FROM AN ELEVATION OF 7,000 FEET

The journey from Oahu to Hawaii was broken on the trip out at Kahului, but the return journey of 235 miles was made, without stop, in two hours and twenty-five minutes (see map, page 123).

Official photograph, U. S. Army Air Service, Photographic Section

WAIPIO VALLEY, A SMOOTH, NARROW VALLEY ON THE NORTHEAST COAST OF THE ISLAND OF HAWAII

In his account of the flight from Luke Field, on the island of Oahu, to the island of Hawaii, Lieutenant Wriston relates a thrilling experience, when the squadron of planes was forced down by storm clouds until the airmen were barely skimming a cliff. When the cliff came too close for comfort, the aviators took to the sea, flying at about 1,000 feet elevation. Despite the danger, which seemed imminent, of being lost in the rain and clouds, the airmen were compelled to admire the beauty of the scenery—numerous waterfalls breaking upon the cliffs, with here and there smooth, narrow valleys, small farms, and villages. A forced landing here would have been desperate, indeed.

Official photograph, U. S. Army Air Service, Photographic Section

KILAUEA MILITARY CAMP AND THE CRATER: PHOTOGRAPH TAKEN FROM AN ELEVATION OF 500 FEET

The island of Hawaii is peculiar in that it has, in its vast extent of 4,000 square miles, scarcely a place which is naturally suitable for a landing field, without the expenditure of considerable labor and money. Being the last of the islands to be formed by Nature, it still is in a "raw state." Its immense mountains and its vast plains have in their formation considered not the airplane and its needs. Rough lava flows, boulders, earthquake cracks, and dense tropical vegetation alike offer poor facilities for a landing. A landing field was finally prepared on a stretch of old lava within the crater of the volcano itself (see page 228).

Official photograph, U. S. Army Air Service, Photographic Section

EARTHQUAKE CRACKS AND STEAM VENTS WEST OF KILAUEA CRATER

After gaining the necessary altitude, the airmen swooped down across the pit of Kilauea, barely 10 feet above the rim, at an indicated speed of 120 miles an hour. On the return trip the plane crossed, at 80 miles an hour, so close that a slight "zoom" was necessary to clear the farther wall. It proved rough flying, not in the way that ordinary rough flying is bumpy: there were hard, sudden bumps, causing a continual flutter, which kept the plane rocking while passing over the pit.

Official photograph, U. S. Army Air Service, Photographic Section

APPROACHING THE PIT OF KILAUEA AT AN ALTITUDE OF 1,000 FEET (SEE ALSO ILLUSTRATION, PAGE 184)

The pit was photographed from various angles and from points closer and closer to the edge, until a view was taken on a sharp angle looking directly into the writhing, boiling, red-hot lava (see page 232). The camera airman here began to experience "rough weather," and could smell the fumes of sulphur despite his rapid passage. As he flew to the windward of the pit, his goggles were suddenly clouded with what appeared to be a fine dust. An old lava flow is utilized as a landing field, on which an airplane may be seen near the white automobile road.

Official photograph, U. S. Army Air Service, Photographic Section

THE FIRST AËRIAL PHOTOGRAPH EVER MADE OF THE FAMOUS "FIRE PIT" IN THE CRATER OF KILAUEA: ON THE ISLAND OF HAWAII
(SEE PAGE 184 AND COLOR PLATES IV AND V)

of lava; of terrible clinkers and taffy-like satin rock dotted with thousands of cones, some very large, others mere baby craters, which remain as monuments of the powerful fires raging inside this immense dome.

At the end of nine hours' easy traveling, we reached the comfortable rest-house at Puu Ulaula, where we were to pass the night (see page 182).

So gentle had been our ascent that not till we dismounted and paused to look behind and around did we realize the distance we had traversed or the height to which we had ascended.

Many miles away and far below, a great slanting column of white smoke shone silver in the sun; this was the fume cloud that is ever rising from the "Pit of Everlasting Fire," Kilauea (see page 188).

A few hundred yards to the north a group of exquisitely formed cinder cones (see page 208) marked the scene of some former volcanic tempest, which might have occurred a year, a century, a millennium before our visit. The alternations of heat and cold, of rain and snow, seem to leave no effect upon the mountain's surface at this elevation. At least, to our eyes there were no evidences of decomposition by the weathering of time.

From the heights of these cones we could trace the course of the great black river of the 1880-1881 eruption, which had burst from the flanks of the mountain near by and for a while threatened to bury Hilo (see map, page 183). As we followed its track, we could easily picture the state of mind of the people of that lovely town as the river of molten rock headed for their homes. It pushed so near that they could feel its fiery breath in the city streets, and its foul sulphurous stench blotted out the fragrance of Hilo's exquisite gardens.

PRINCESS' HAIR PROPITIATED THE FIRE DRAGON

What stopped that obliterating mass a scant half mile from the city gates?

The native Hawaiians say that after every recourse of the missionaries had failed, the Princess Kamehamena, the last of the royal family, was begged, in accordance with the ancient custom, to cast a lock of her raven hair into the stream. The Princess consented and sacrificed one of her loveliest tresses; the stream was appeased, "the great red dragon lay stiffened and harmless" a few yards from the town, and the record held by Samson's locks since biblical days passed to Hawaiian tresses.

This river of melted rock had been moving for six months, varying in speed from 15 miles an hour in the earlier stages to a few feet per day. It had advanced 35 miles and covered an area greater than the State of Rhode Island some feet deep; and yet, in proportion to the bulk of this huge dome, was no larger than one slap of paint from a brush is compared to the whole house.

No words can picture the soft, fleecy, rounded blanket of cloud masses, white as purest snow, which gathered as the sun dropped behind the horizon, and nestled close around the mountain below us (see pages 184 and 208).

Presently the snowy mantle also enfolded our neighbor, Mauna Kea, until only her summit was visible. Peering above the blanket of cloud, 100 miles away, appeared the huge bulk of Haleakala volcano, on the island of Maui, which we had ascended a few days before (see pages 128, 207, and 226).

A NIGHT OF COMFORT IN THE REST-HOUSE

We had been keeping a rather strenuous program for some weeks, and as we enjoyed the comfort of that rest-house, with its roomy bunks, wood stove, and tight walls, which shut out the cold and penetrating wind, notwithstanding our agreement to get up at daylight I should not have been much disappointed if our experience next day had been like Mark Twain's on a similar occasion. He has described how he and his companions reluctantly struggled out of their bunks and, wrapping themselves in their blankets, sat down outside and waited for the sun to rise; but instead of getting lighter, the sky became darker and darker. The sun was going down, not up!

Resuming our journey to the crater the next morning, we passed strings of "coke ovens," originally gas vents whose domes had collapsed.

Occasionally, softly flowing jets of evil-smelling steam by the trail reminded us that fires are still glowing inside.

Photograph by C. S. Carlsmith

RED-HOT CREEPING TOES SLOWLY SPREADING OVER THE FLOOR OF HALEMAUMAU (EVERLASTING FIRE): ACTIVE CRATER OF KILAUEA

Photograph by Hawaiian Volcano Observatory

FOUNTAINING VENT NORTH OF HALEMAUMAU WHERE, ON NOVEMBER 1, THE LIQUID WELLED UP THROUGH THE GROUND SIMULTANEOUSLY WITH AN EARTHQUAKE

Like an artesian well, it sent floods in all directions.

Photograph by Hawaiian Volcano Observatory

ONE OF THE GREAT RAFTS IN THE AA LAVA OF THE ALIKA FLOW, MAUNA LOA

To the Hawaiian language scientists are indebted for the terms used to distinguish the two different kinds of volcanic lava. One type, resembling rough clinkers or slag from a furnace, is named AA (see pages 188, 209, 222); the other type, which is smooth and shiny glass, is known as pahoehoe (see pages 187, 210, and 234).

The ascent continued so gradual that we were hardly conscious of the fact that we were mounting with every step.

A few miles farther on we traversed a lumpy, rolling sheet of colored glass, extending as far as the eye could reach, glistening at times with the radiance of countless jewels, sparkling with the brilliance of diamonds and rubies and sapphires or softly glowing like black opals and iridescent pearls. The hoofs of our animals broke through this satin stream with a crunching sound, as if they were piercing the crust of frozen snow (see page 210).

Next we passed a perfectly symmetrical blood-red cone in a frozen jet-black shining sea of obsidian—a lovely sight—and a few hundred yards farther on a red cone and a black cone side by side.

An hour later we noted long tongues of brilliant red AA which had thrust across a field of yellow volcanic sand.

The goddess of the volcano, like all vigorous savages, delights in strong, positive colors. Thus each lava flow sharply

Photograph by Gilbert Grosvenor

INTERIOR VIEW OF THE TUBE, OR TUNNEL, THROUGH WHICH A FEW WEEKS EARLIER THE RIVER OF FIRE (COLOR PLATE V) HAD RUSHED

differs from its neighbors. As we crossed a jet-black flow of congealed lava, we skirted a bright red-brick cone, and in the distance clearly visible could trace the course of other flows in bronze, slate, pink, and chocolate.

The colors soften the sense of terrific desolation.

THE FORTITUDE OF ADMIRAL WILKES IS RECALLED

As we traveled through this frightful waste on a well-marked trail, comfortably on able mules, dismounting only when the trail became especially rough or our mules sank to their bellies in the powdered glass, our thoughts reverted with admiration and wonder to that U. S. Navy hero, Charles Wilkes, who 80 years before, without the assistance of such trusty animals as ours, had conducted a party of American officers and bluejackets to the crater's rim and camped on the cold, bleak, barren summit for three weeks in the depth of winter.

In his pursuit of knowledge, Admiral Wilkes was relentless and indifferent to physical feelings, and similarly inspired all associated with him. Since his time few have spent more than a night on the summit. Wilkes built a walled village on the crater's edge, and here for more than twenty days he resolutely conducted magnetic and pendulum observations. Often the cold was so intense in his tent that water froze "within a couple of feet of the fire, when it was giving out the most heat," and water in the bags froze under his pillow.

THE FOUNTAIN HEAD OF FOUR VOLCANIC MOUNTAINS

About noon we reached the edge of the crater. Several hundred feet below us stretched the crater floor, an extensive gray, slaty, hard surface, rather rough and exhibiting no signs of warmth or activity, except in the further corner, where some steam was slowly rising (see page 211). That gray floor temporarily capped a gusher that had been operating for thousands of years.

It was intensely interesting to behold

Photograph by Hawaiian Volcano Observatory

LOOKING INTO AN INCANDESCENT GROTTO

Lava was splashing below in bright yellow heat and gas-melted stalactites hung from the roof like bunches of fiery grapes.

the fountain head of the volcanic stream that had constructed the four great mountains forming the island—probably the most unusual group of volcanoes on earth.

From our present knowledge, geologists are inclined to believe that when this spouting stream, which originated many miles down in the bowels of the earth, had raised Mauna Kea to its present height of 13,823 feet, it could force itself no higher and, being compelled to seek outlets elsewhere, formed Hualalai, 8,269 feet, and Kilauea. Then it transferred its energies again and erected Mauna Loa, the giant of them all—a tremendous turtle-back 60 miles across and 200 miles in circumference at sea level.

Mauna Loa is very venerable, but still probably in its vigorous prime. It has become so lofty that when the fires inside would escape, the liquid now finds egress from the flanks rather than from the summit crater, and these flows radiate from the mountain like the spokes of a wheel (see map, page 183) and threaten to bury Kilauea.

Photograph by Hawaiian Volcano Observatory

A SPATTER CONE SPINNING PELE'S HAIR ON THE EDGE OF THE PIT OF KILAUEA

As the lava boils and spits, the wind snatches the threads of spume and scatters them broadcast. Thus the neighborhood becomes covered with cobwebs of glass.

"The cause of the steady upflow," Dr. Jaggar has stated, "may be a subsiding of the ocean's bottom all about, or it may be the elastic force contained within the liquid itself or its imprisoned gases."

"I can never hope again to witness so sublime a scene," wrote Admiral Wilkes in 1840. "The very idea of standing on the summit of one of the highest peaks in the midst of this vast ocean, in close proximity to a precipice of profound depth, overhanging an immense crater 'outrageous as a sea' with molten rock, would have been exciting even to a strong man; but the sensation was overpowering to one already exhausted by breathing the rarefied air and toiling over the lava which this huge caldron must have vomited forth in quantities sufficient to form a dome sixty miles in diameter and nearly three miles in height."

SOME DAY MAUNA LOA WILL BE ACCESSIBLE TO ALL

We could not linger more than an hour at the crater's rim, as it was essential to return to the half-way house before dark. As on the previous evening, the blanket of cloud, slowly forming at nightfall, enveloped the mountain below. This belt of cloud dissolved in the morning when the sun lifted, revealing Hilo 35 miles to the east and Kilauea, puffing away as vigorously as before, some 20 miles away.

Some day we hope that the marvelous experience which had been our privilege will be available to many. At present the excursion to the summit is not popular. For one who travels afoot the distances between rest-houses impose a tax that is dangerous, except for the most athletic; while those who would ride find the ranchers justly refuse to rent their mules for a journey that leaves the animals with feet and legs so badly cut by jagged lava and volcanic glass that they cannot be used again for weeks.

Later Mauna Loa will be made accessible by easy trails, hotels, and rest-houses, and be, like Etna, in Sicily, or Haleakala, on Maui, the common resort of tourists, alpinists, and the people of the Islands. Its wonderful forest glades, deep clefts, lava cones and pits, cliffs, vistas, and climates are at present unknown; and yet this volcanic height is one of the marvels of the world, unique among our national parks.

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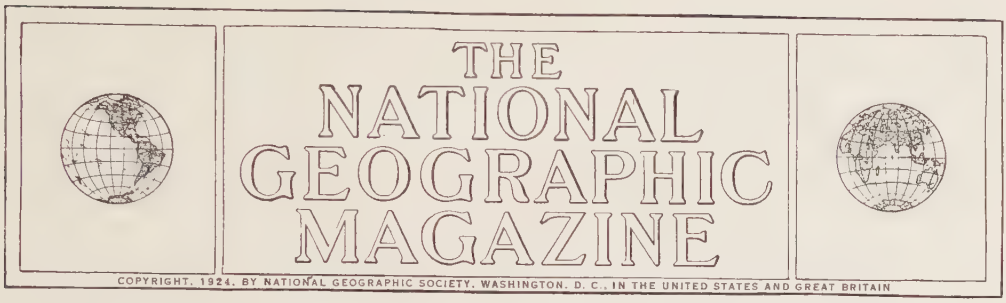

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GEOGRAPHY AND SOME EXPLORERS

By Joseph Conrad

IT IS safe to say that for the majority of mankind the superiority of geography over geometry lies in the appeal of its figures. It may be an effect of the incorrigible frivolity inherent in human nature, but most of us will agree that a map is more fascinating to look at than a figure in a treatise on conic section—at any rate, for the simple minds which are the equipment of the majority of the dwellers on this earth.

No doubt a trigonometrical survey may be a romantic undertaking, striding over deserts and leaping over valleys never before trodden by the foot of civilized man; but its accurate operations can never have for us the fascination of the first hazardous steps of a venturesome, often lonely, explorer jotting down by the light of his camp fire the thoughts, the impressions, and the toil of his day.

For a long time yet, a few suggestive words grappling with things seen will have the advantage over a long array of precise, no doubt interesting, and even profitable figures. The earth is a stage, and though it may be an advantage, even to the right comprehension of the play, to know its exact configuration, it is always the drama of human endeavor that will be the thing, with a ruling passion expressed by outward action marching perhaps blindly to success or failure, which themselves are often undistinguishable from each other at first.

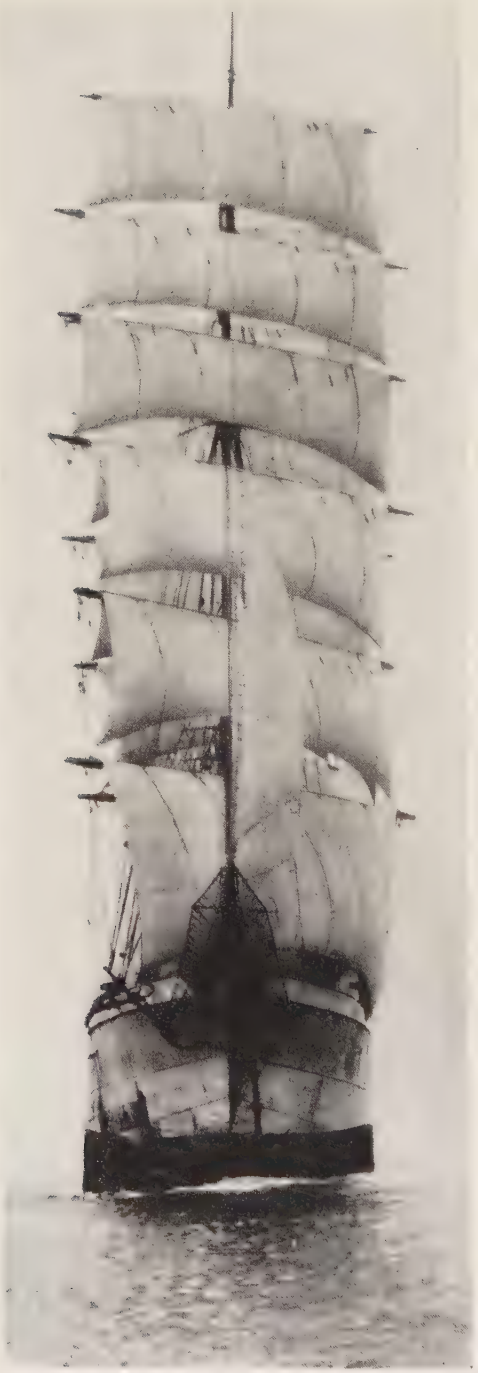
GEOGRAPHY IS THE SCIENCE OF ACTION

Of all the sciences, geography finds its origin in action, and, what is more, in adventurous action, of the kind that appeals to sedentary people, who like to dream of arduous adventure in the manner of prisoners dreaming behind their bars of all the hardships and hazards of liberty, dear to the heart of man.

Descriptive geography, like any other kind of science, has been built on the experience of certain phenomena and on experiments prompted by that unappeasable curiosity of men which their intelligence has elevated into a quite respectable passion for acquiring knowledge. Like other sciences, it has fought its way to truth through a long series of errors. It has suffered from the love of the marvelous, from our credulity, from rash and unwarrantable assumptions, from the play of unbridled fancy.

Geography had its phase of circumstantially extravagant speculation which had nothing to do with the pursuit of truth, but has given us a curious glimpse of the medieval mind playing in its ponderous, childish way with the problems of our earth's shape, its size, its character, its products, its inhabitants.

Cartography was almost as pictorial then as some modern newspapers. It crowded its maps with pictures of strange pageants, strange trees, strange beasts, drawn with amazing precision in the midst of theoretically conceived continents. It delineated imaginary kingdoms of Monomotapa and of Prester John, the regions infested by lions or haunted by unicorns, inhabited by men with reversed feet or eyes in the middle of their breasts.



AN ALLY OF GEOGRAPHY MILITANT

The four-masted square-rigged *Nereos* under full sail. "The unchangeable sea preserves the memory of things accomplished by wisdom and daring among its restless waves" (see text, page 272).

All this might have been amusing if the medieval gravity in the absurd had not been in itself a wearisome thing. But what of that! Has not the key science of modern chemistry passed through its dishonest phase of alchemy (a portentous development of the confidence-trick), and our knowledge of the starry sky been arrived at through the superstitious idealism of astrology looking for men's fate in the depths of the infinite! Mere megalomania on a colossal scale. Yet, solemn fooling for solemn fooling of the scientific order, I prefer the kind that does not lay itself out to thrive on the fears and the cupidities of men.

THE GREATEST GEOGRAPHER OF ALL TIMES WAS REWARDED WITH CHAINS

From that point of view geography is the most blameless of sciences. Its fabulous phase never aimed at cheating simple mortals (who are a multitude) out of their peace of mind or their money. At the most, it has enticed some of them away from their homes—to death, maybe; now and then to a little disputed glory, not seldom to contumely, never to high fortune. The greatest of them all, who has presented modern geography with a new world to work upon, was at one time loaded with chains and thrown into prison.

Columbus remains a pathetic figure, not a sufferer in the cause of geography, but a victim of the imperfections of jealous human hearts, accepting his fate with resignation. Among explorers, he appears lofty in his troubles and like a man of a kingly nature. His contribution to the knowledge of the earth was certainly royal.

And if the discovery of America was the occasion of the greatest outburst of reckless cruelty and greed known to history, we may say this, at least, for it, that the gold of Mexico and Peru, unlike the gold of alchemists, was really there—palpable, yet, as ever, the most elusive of the Fata Morgana that lure men away from their homes—as a moment of reflection will convince any one; for nothing is more certain than that there will never be enough gold to go round, as the Conquistadores found out by experience.

Photograph from N. H. Darton

A REPRODUCTION OF COLUMBUS' FLAGSHIP, THE "SANTA MARIA"

"The greatest explorer of them all has presented modern geography with a new world to work upon" (see text, page 240).

I suppose it is not very charitable of me, but I must say that to this day I feel a malicious pleasure at the many disappointments of those pertinacious searchers for El Dorado who climbed mountains, pushed through forests, swam rivers, floundered in bogs, without giving a single thought to the science of geography.

Not for them the serene joys of scientific research, but infinite toil, in hunger, thirst, sickness, battle; with broken heads, unseemly squabbles, and empty pockets in the end. I cannot help thinking it served them right. It is an ugly tale, which has not much to do with the service of geography.

The geographical knowledge of our day is of the kind that would have been beyond the conception of the hardy followers of Cortez and Pizarro, and of that most estimable of conquerors who was called Cabeza de Vaca, who was high-minded and dealt humanely with the heathen nations whose territories he traversed in search of one more El Dorado. It is said they loved him greatly; but now the very memory of those nations is gone from the earth, while their territories, which they could not take with them, are being traversed many times every twenty-four hours by the trains of the Southern Pacific Railroad.

VIRGINIAE
Item et
FLORIDAE
Americæ Provinciarum, nova
DESCRIPTIO.
AMERI CÆ
PARS.
FLO RI DÆ
PARS
Apalatey Montes auriferi
Lacus 3 insulæ Sarropeabin
Florida hanc latus extenditur
Mathaqua
Routaqua
Utrita
Emolona
Mathusa
Mallona
Sabina del Saturna
Chiaccara
Mocoso
Malatacare
Mocoso
Mocoso
Mocoso

The discovery of the New World marks the end of the fabulous geography, and it must be owned that the history of the conquest contains at least one great moment—I mean a geographically great moment—when Vasco Nuñez de Balboa, while crossing the Isthmus of Panama, set his eyes for the first time upon the ocean the immensity of which he did not suspect and which in his elation he named the Pacific. It is anything but that; but the privileged Conquistador cannot be blamed for surrendering to his first impression.

The Gulf of Panama, which is what he really saw with that first glance, is one of the calmest spots on the waters of the globe. Too calm. The old navigators dreaded it as a dangerous region, where one might be caught and lie becalmed for weeks, with one's crew dying slowly of thirst, under a cloudless sky. The worst of fates, this, to feel yourself die in a long and helpless agony. How much preferable a region of storms, where man and ship can at least put up a fight and remain defiant almost to the last.

I must not be understood to mean that a tempest at sea is a delightful experience, but I would rather face the fiercest tempest than a gulf pacific even to deadliness, a prison-house for incautious caravels and a place of torture for their crews.

But Balboa was charmed with its serene aspect. He did not know where he was. He probably thought himself within a stone's throw, as it were, of the Indies and Cathay.

Or did he, perhaps, like a man touched with grace, have a moment of exalted vision, the awed feeling that what he was looking at was an abyss of waters comparable in its extent to the view of the unfathomable firmament, and sown all over with groups of islands resembling the constellations of the sky?

EARLY GEOGRAPHERS SOUGHT IN VAIN FOR GREAT SOUTHERN CONTINENT

But, whatever spiritual glimpse of the truth he might have had, Balboa could not possibly know that this great moment of his life had added suddenly thousands of miles to the circumference of the globe, had opened an immense theater for the human drama of adventure and exploration, a field for missionary labors, and spread an enormous canvas on which some geographers could paint the most fanciful variants of their pet theory of a great southern continent.

I will not quarrel with the post-Columbian cartographers for their wild but upon the whole interesting inventions. The provocation to let oneself go was considerable.

Geography militant, which had succeeded the geography fabulous, did not seem able to accept the idea that there was much more water than land on this globe. Nothing could satisfy their sense of the fitness of things but an enormous extent of solid earth, which they placed in that region of the south where, as a matter of fact, the great white-crested seas of stormy latitudes will be free to chase each other all round the globe to the end of time.

I suppose their landsmen's temperament stood in the way of their recognition that the world of geography, as far as the apportioning of space goes, seems to have been planned mostly for the convenience of fishes.

TASMAN THOUGHT HE HAD FOUND THE CONTINENT

What is surprising to me is that the seamen of the time should have really believed that the large continents to the north of the Equator demanded, as a matter of good art or else of sound science, to be balanced by corresponding masses of land in the southern hemisphere. They were simple souls. The chorus of people all singing the same tune made them blind to the many plain signs of a great open sea. Every bit of coastline discovered, every mountain top glimpsed in the distance, had to be dragged loyally into the scheme of the Terra Australis Incognita.

Even Tasman, the best seaman of them all before James Cook, the most accomplished of seventeenth century explorers and navigators, that went forth to settle the geography of the Pacific—even Tasman, after coming unexpectedly upon the North Island of New Zealand, and lingering long enough there to chart roughly a bit of the coast and lose a boat's crew in a sudden affray with the Maoris, seemed to take it for granted that this was the western limit of an enormous

Photograph by Kilophot

ST. JOHN OF NEPOMUK, PATRON SAINT OF THOSE WHO FACE DANGER BY WATER

This statue overlooks the harbor of Riva, on Lake Garda, northern Italy.

Photograph by Maynard Owen Williams

A FISHING BOAT AT PORT SAID

The craft is manned by Italians from Bari, three of whom have gone aloft to furl the sail.

© Publishers' Photo Service

ENTRANCE TO THE SUEZ CANAL, WITH THE STATUE OF FERDINAND DE LESSEPS TO THE RIGHT

The French diplomatist de Lesseps, then 27 years of age, conceived the idea of the Suez Canal while his vessel was held in quarantine at Alexandria in 1832. Twenty-seven years later at Port Said he struck the first blow with a pickax, which finally resulted in the completion of the short water route to the Far East in 1869, thus supplanting Vasco da Gama's route to the Indies around Cape of Good Hope.

continent extending away toward the point of South America.

Mighty is the power of a theory, especially if based on such a common-sense notion as the balance of continents. And it must be remembered that it is difficult for us now to realize not only the navigational dangers of unknown seas, but the awful geographical incertitudes of the first explorers in that new world of waters.

Tasman's journal, which has been published not so very long ago, gives us some idea of their perplexing difficulties. The early navigators had no means of ascertaining their exact position on the globe. They could calculate their latitude, but the problem of longitude was a matter which bewildered their minds and often falsified their judgment. It had to be a matter of pure guesswork.

TASMAN CENSURED BY HIS EMPLOYERS

Tasman and his officers, when they met on board the *Heemskirk*, anchored in Murderers' Bay, to consider their further course in the light of their instructions, did not know where any of the problematic places named in their instructions were; neither did they know where they themselves were.

Tasman might have sailed north or east, but in the end he decided to sail between the two, and, circling about, returned to Batavia, was received coldly by his employers, the honorable governor-general and the council in Batavia. Their final judgment was that Abel Tasman was a skillful navigator, but that he had shown himself "remiss" in his investigations, and that he had been guilty of leaving certain problems unsolved.

We are told that Tasman did not expect this criticism; and indeed, even now, it seems surprising to an unprejudiced mind. It was the voyage during which, among other things, Tasman discovered the island by which his name lives on the charts, took first contact with New Zealand (which was not seen again till 130 years afterwards), sailed over many thousands of miles of uncharted seas, bringing back with him a journal which was of much value afterwards for his exploring successors.

It may be he was hurt by the verdict of the honorable council, but he does not seem to have been cast down by it, for it appears that shortly afterwards he asked for a rise of salary and, what is still more significant, he got it. He was obviously a valuable servant, but I am sorry to say that his character as a man was not of the kind to cause governors and councils to treat him with particular consideration.

Except in professional achievement, he is not comparable to Captain Cook, a humble son of the soil like himself, but a modest man of genius, the familiar associate of the most learned in the land, medalist of the Royal Society and a captain in the Royal Navy.

But there was a taint of an unscrupulous adventurer in Tasman. It is certain that at various times his patron, the Governor Anthony Van Diemen, and the honorable council in Batavia had employed him in some shady transactions of their own connected with the Japan trade.

There is also no doubt that once he had, on his own responsibility, kidnapped an influential Chinaman who stood in the way of some business negotiation Tasman was conducting with the Sultan of Achin. The Chinaman may have been a worthless person, but one wonders what happened to him in the end; and in any case the proceeding is open to criticism.

Then in his old age Tasman got into some disreputable scrape which caused the congregation with which he worshiped to ask him to resign his membership. Even the honorable council was startled and dismissed him from his employment, though characteristically enough not actually from their service. This action of the council fixes the character of the man better than any scandalous story. He was valuable, but compromising.

CAPTAIN COOK LAID THE GHOST OF TERRA AUSTRALIS INCOGNITA

All those regrettable details came to my knowledge quite recently in a very amusing and interesting book, but I must confess that my early admiration for Tasman as one of the early fathers of militant geography has not been affected very much by it.

Remiss or not, he had in the course of his voyages mapped 8,000 miles of an island which by common consent is called now a continent, a geologically very old continent indeed, but which is now the

Photograph by Walter Layman

THE GATEWAY TO THE NEW WORLD: NEW YORK FROM GOVERNORS ISLAND

Photograph by Mrs. Mary G. Lucas

COALING SHIP AT NAGASAKI, THE FIRST PORT OF ENTRY FOR VESSELS COMING FROM THE SOUTH OR THE WEST TO JAPAN

Photograph from J. W. Beattie

SOUTH SEA ISLAND TRADERS: LA PÉROUSE ARCHIPELAGO

These natives are from Santa Cruz, the chief island of the archipelago named for the great French navigator, La Pérouse, who sailed from Botany Bay in 1788 and was not heard of again until the wreckage of his two vessels, the *Boussole* and the *Astrolabe,* was found near here, 38 years later.

home of a very young Commonwealth, with all the possibilities of material and intellectual splendor still hidden in its future.

I like to think that in that portion of the Elysian Fields set apart for great navigators James Cook would not refuse to acknowledge the civilities of Abel Tasman, a fellow-seaman who had first reported the existence of New Zealand in the perplexed bewildered way of those times, a hundred and thirty years before Captain Cook, on his second voyage, laid forever the ghost of the Terra Australis Incognita and added New Zealand to the scientific domain of the geography triumphant of our day.

No shade of remissness nor doubtful motive rests upon the achievements of Captain Cook, who came out of a laborer's cottage to take his place at the head of great masters of maritime exploration who worked at the great geographical problem of the Pacific. *Endeavour* was the name of the ship which carried him on his first voyage, and it was also the watchword of his professional life. *Resolution* was the name of the ship he commanded himself on his second expedition, and it was the determining quality of his soul. I will not say that it was the greatest, because he had all the other manly qualities of a great man.

The voyages of the early explorers

Photograph from Dr. Hugh M. Smith

A NORWEGIAN FISHING BOAT

Its lines are suggestive of the boats of the Vikings.

were prompted by an acquisitive spirit, the idea of lucre in some form, the desire of trade or the desire of loot, disguised in more or less fine words. But Cook's three voyages are free from any taint of that sort. His aims needed no disguise. They were scientific. His deeds speak for themselves with the masterly simplicity of a hard-won success.

In that respect he seems to belong to the single-minded explorers of the nineteenth century, the late fathers of militant geography, whose only object was the search for truth. Geography is a science of facts, and they devoted themselves to the discovery of facts in the configuration and features of the great continents.

A GREAT EXPLORER WHO SERVED GEOGRAPHY EVEN IN HIS DEATH

It was the century of landsmen investigators. In saying this I do not forget the polar explorers, whose aims were certainly as pure as the air of those high latitudes where not a few of them laid down their lives for the advancement of geography. Seamen, men of science, it

Photograph by T. Alexander Barns

THE MEMORIAL TABLET WHICH MARKS THE SPOT WHERE STANLEY MET LIVINGSTONE AT UJIJI, ON THE SHORES OF LAKE TANGANYIKA, IN 1871

The mango tree was planted by the two great explorers to commemorate the event, and the memorial was built round it during the occupation of Ujiji by the Belgian troops during the German East African campaign. Unfortunately, the tree is now dying as a result of the cement work, in spite of the fact that the roots have cracked the masonry (see text, page 271).

is difficult to speak of them without admirative emotion.

The dominating figure among the seamen explorers of the first half of the nineteenth century is that of another good man, Sir John Franklin, whose fame rests not only on the extent of his discoveries, but on professional prestige and high personal character.

This great navigator, who never returned home, served geography even in his death. The persistent efforts, extending over ten years, to ascertain his fate advanced greatly our knowledge of the polar regions.

As gradually revealed to the world, this fate appeared the more tragic in this, that for the first two years the way of the *Erebus* and *Terror* expedition seemed to be the way to the desired and important success, while in truth it was all the time the way of death, the end of the greatest drama, perhaps, played behind the curtain of Arctic mystery.

The last words unveiling the mystery of the *Erebus* and *Terror* expedition were brought home and disclosed to the world by Sir Leopold M'Clintock in his book, "The Voyage of the *Fox* in the Arctic Seas."

It is a little book, but it records with manly simplicity the tragic ending of a great tale. It so happened that I was born in the year of its publication. Therefore I may be excused for not getting hold of it till ten years afterwards. I can only account for it falling into my hands by the fact that the fate of Sir John Franklin was a matter of European interest, and that Sir Leopold M'Clintock's book was translated, I believe, into every language of the white races.

My copy was probably in French. But I have read the work many times since. I have now on my shelves a copy of a popular edition got up exactly as I remember my first one.

It contains the touching facsimile of

Photograph from Hon. James G. Whiteley

FISHERMEN AT STANLEY FALLS, BELGIAN CONGO

"I was glad to be alone on deck. . . . The subdued thundering mutter of the Stanley Falls hung in the heavy night air of the last navigable reach of the upper Congo" (see text, page 271).

the printed form filled in with a summary record of the two ships' work, the name of "Sir John Franklin, commanding the expedition," written in ink, and the pathetic underlined entry, *"All well."* It was found by Sir Leopold M'Clintock under a cairn, and it is dated just a year before the two ships had to be abandoned in their deadly ice-trap and their crews' long and desperate struggle for life began.

There could hardly have been imagined a better book for letting in the breath of the stern romance of polar exploration into the existence of a boy whose knowledge of the poles of the earth had been till then of an abstract, formal kind, as the imaginary ends of the imaginary axis upon which the earth turns.

The great spirit of the realities of the story sent me off on the romantic explorations of my inner self; to the discovery of the taste for poring over land and sea maps; revealed to me the existence of a latent devotion to geography which interfered with my devotion (such as it was) to my other school work.

Unfortunately, the marks awarded for that subject were almost as few as the hours apportioned to it in the school curriculum by persons of no romantic sense for the real, ignorant of the great possibilities of active life; with no desire for struggle, no notion of the wide spaces of the world — mere bored professors, in fact, who were not only middle-aged, but looked to me as if they had never been young.

And their geography was very much like themselves, a bloodless thing, with a dry skin covering a repulsive armature of uninteresting bones.

I would be ashamed of my warmth in digging up a hatchet which has been buried now for nearly fifty years if those fellows had not tried so often to take my scalp at the yearly examinations. There are things that one does not forget.

And, besides, the geography which I had discovered for myself was the geography of open spaces and wide horizons, built up on men's devoted work in the open air, the geography still militant, but

already conscious of its approaching end with the death of the last great explorer. The antagonism was radical.

Thus it happened that I got no marks at all for my first and only paper on Arctic geography, which I wrote at the age of thirteen. I still think that for my tender years it was an erudite performance. I certainly did know something of Arctic geography, but what I was after really, I suppose, was the history of Arctic exploration.

My knowledge had considerable gaps, but I managed to compress my enthusiasm into just two pages, which in itself was a sort of merit.

Yet I got no marks. For one thing, it was not a set subject. I believe the only comment made about it to my private tutor was that I seemed to have been wasting my time in reading books of travel instead of attending to my studies.

I tell you, those fellows were always trying to take my scalp. On another occasion I just saved it by proficiency in map drawing. It must have been good, I suppose; but all I remember about it is that it was done in a loving spirit.

MAP-GAZING IS A MORE FASCINATING OCCUPATION THAN STAR-GAZING

I have no doubt that star-gazing is a fine occupation, for it leads you within the borders of the unattainable. But map-gazing, to which I became addicted so early, brings the problems of the great spaces of the earth into stimulating and directive contact with sane curiosity and gives an honest precision to one's imaginative faculty.

And the honest maps of the nineteenth century nourished in me a passionate interest in the truth of geographical facts and a desire for precise knowledge which was extended later to other subjects.

For a change had come over the spirit of cartographers. From the middle of the eighteenth century on, the business of map-making had been growing into an honest occupation, registering the hard-won knowledge, but also, in a scientific spirit, recording the geographical ignorance of its time.

And it was Africa, the continent out of which the Romans used to say some new thing was always coming, that got cleared of the dull imaginary wonders of the Dark Ages, which were replaced by exciting spaces of white paper. Regions unknown! My imagination could depict to itself there worthy, adventurous, and devoted men nibbling at the edges, attacking from north and south and east and west, conquering a bit of truth here and a bit of truth there, and sometimes swallowed up by the mystery their hearts were so persistently set on unveiling.

Among them Mungo Park, of Western Sudan, and Bruce, of Abyssinia, were, I believe, the first friends I made when I began to take notice—I mean geographical notice—of the continents of the world into which I was born. The fame of these two had already been for a long time European, and their figures had become historical by then. But their story was a very novel thing to me; for the very latest geographical news that could have been whispered to me in my cradle was that of the expedition of Burton and Speke, the news of the existence of Tanganyika and of Victoria Nyanza.

I stand here confessed as a contemporary of the Great Lakes of Africa. Yes, I could have heard of their discovery in my cradle, and it was only right that, grown to a boy's estate, I should have in the later sixties done my first bit of map-drawing and paid my first homage to the prestige of their first explorers. It consisted in entering laboriously in pencil the outline of Tanganyika on my beloved old atlas, which, having been published in 1852, knew nothing, of course, of the Great Lakes. The heart of its Africa was white and big.

Surely it could have been nothing but a romantic impulse which prompted the idea of bringing it up to date with all the accuracy of which I was capable. Thus I could imagine myself stepping in the very footprints of geographical discovery.

And it was not all wasted time. As a bit of prophetic practice, it was not bad for me. Many years afterwards, as second officer in the Merchant Service, it has been my duty to correct and bring up to date the charts of more than one ship, according to the Admiralty notices. I did this work conscientiously, of course, and with a sense of responsibility; but it was not in the nature of things that I should ever recapture the excitement of

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"THE AIMS OF POLAR EXPLORERS HAVE BEEN AS PURE AS THE AIR OF THOSE HIGH LATITUDES" (SEE TEXT, PAGE 251)

The *Terra Nova,* ship of the Captain Robert F. Scott South Polar party, icebound in the pack. This and the succeeding 15 illustrations are from photographs by Herbert G. Ponting, official photographer of the British Antarctic Expedition (see also an earlier series of illustrations by Mr. Ponting, "Life in the Antarctic," in THE GEOGRAPHIC for December, 1922).

© Herbert G. Ponting

PACK ICE SEEN FROM THE MAINTOP OF THE "TERRA NOVA"

Captain Scott's vessel unfortunately encountered the pack early in its southward voyage and in 20 days had to push through 370 miles of heavy ice. Floes rising 7 or 8 feet out of the water, with pinnacles 25 feet high, were encountered.

© Herbert G. Ponting

LOOKING SOUTH UPON HUT POINT AND VINCE CROSS

Captain Scott used this point as his base of operations during his expedition of 1901-04 and visited it again in 1911. The white wooden cross was erected to the memory of George T. Vince, one of the men of the *Discovery* who lost his life on the ice-fall

© Herbert G. Ponting

MT. EREBUS SEEN OVER A WATER-WORN ICEBERG

Mt. Erebus (13,350 feet) and Mt. Terror (10,750 feet) are the two loftiest volcanic sentinels of the Antarctic. Erebus is active; Terror, quiescent. The furrows in the overturned iceberg in the foreground have been caused by the action of water

CASTLE ICEBERG FROZEN INTO THE ICE NEAR THE HUT ON CAPE EVANS

© Herbert G. Ponting

© Herbert G. Ponting

VIDA, LEADER OF ONE OF THE DOG TEAMS OF THE SCOTT POLAR EXPEDITION

The Scott party carried thirty-three dogs—thirty Eastern Siberian males, two Eskimo, and one New Zealand collie. The largest of these weighed less than eighty pounds, but a team of eleven could pull a load of a thousand pounds fifteen miles in four hours. Vida was a proud creature, seemingly fully conscious of his own strength and fitness for his work.

© Herbert G. Ponting

PENGUINS MAKING FOR THE WATER

These quaint creatures of the Antarctic have a layer of three-quarters of an inch of pure fat under their skins. The oil obtained from their blubber burns much more fiercely than seal oil. Penguin eggs provide an addition to the menu of the explorer; the flesh, after it freezes, is cut into strips and is often eaten on the march.

© Herbert G. Ponting

THE VOLCANIC PILLAR AT CAPE BARNE

When the heat of the Antarctic summer sun strikes this remarkable column of lava, rising to a height of 250 feet, it gives off showers of fragments. The man at the right, who provided the scale for the photograph, experienced a veritable bombardment.

© Herbert G. Ponting

AT THE THRESHOLD OF AN ICEBERG GROTTO

From the outside, the interior of the berg appeared white and colorless, but from within it shone with iridescent blues and greens. An interior view of this unique cavern was shown in the earlier series of Ponting photographs (December, 1922).

A PRESSURE RIDGE, ONE OF THE OBSTACLES OF ANTARCTIC EXPLORATION

© Herbert G. Ponting

Owing to tremendous pressure, great blocks of ice pile up on both sides of a crack in the frozen sea. The man with the camera is Captain Scott.

© Herbert G. Ponting

FURROWS OF FROZEN SPRAY

After a severe blizzard from the south, which lasted some days, a great part of the coast line at Cape Evans was thickly covered with furrows and

THE "TERRA NOVA" IN MCMURDO SOUND

© Herbert G. Ponting

This photographic study, made on a dead-calm day, shows a berg in the last stages of decay, from the action of the sun and sea. In this condition the ice frequently assumes the most beautiful shapes imaginable, which, when reflected in the surface of the sea, make a scene of extraordinary beauty. Beyond the *Terra Nova* are the peaks of the Western Mountains of Victoria Land, seventy miles away.

© Herbert G. Ponting

SITTING BEFORE A BLUBBER STOVE IN THE ANTARCTIC

The fat of seals is the fuel used in this type of stove. Here Captain Oates and Cecil Meares, of the Scott Expedition, are cooking hoosh, meal

© Herbert G. Ponting

THE RAMPARTS OF MT. EREBUS

Some idea of the immensity and grandeur of the Antarctic scenery is conveyed in this remarkable picture. In the foreground the cliffs of the Barne Glacier present an impregnable crenelated barrier of ice, ages old and more than 100 feet in height at this point. At the foot of this cliff the figure standing by the sledge appears of Lilliputian size. Above the edge of the glacier, fifteen miles distant, but in the clear polar air apparently much nearer, appears Erebus, the great White Queen of the Antarctic, a mass of ice-covered lava (see also illustration, page 258).

© Herbert G. Ponting

A DOG TEAM RESTING BY AN ICEBERG

The birthplace of the thousands of Antarctic icebergs, which break away each year in masses sometimes many miles in length, is the Great Ice Barrier, a vast ice sheet having an aggregate area as large as the combined areas of all the New England States, New York, and Pennsylvania. It has been estimated that one of the icebergs encountered by the last Scott expedition was large enough to have carried on its back the entire city of London and all its suburbs.

© Herbert G. Ponting

THE "TERRA NOVA" IN A GALE

Four days before his death, after he had reached the South Pole and returned within 155 miles of his home base, Captain Scott wrote: "I do not regret this journey, which has shown that Englishmen can endure hardships, help one another, and meet death with as great fortitude as ever in the past. . . . We have been willing to give our lives for this enterprise, which is in honor of our country."

that entry of Tanganyika on the blank of my old atlas.

It must not be supposed that I gave up my interest in the polar regions. My heart and my warm participation swung from the frigid to the torrid zone, fascinated by the problems of each, no doubt, but more yet by the men who, like masters of a great art, worked each according to his temperament to complete the picture of the earth. Almost each day of my schoolboy life had its hour given up to their company. And to this day I think that it was a very good company.

VISIONS OF THREE GREAT AFRICAN EXPLORERS

Not the least interesting part in the study of geographical discovery lies in the insight it gives one into the characters of that special kind of men who devoted the best part of their lives to the exploration of land and sea.

In the world of mentality and imagination which I was entering, it was they, and not the characters of famous fiction, who were my first friends. Of some of them I had soon formed for myself an image indissolubly connected with certain parts of the world. For instance, Western Sudan, of which I could draw the rivers and principal features from memory even now, means for me an episode in Mungo Park's life.

It means for me the vision of a young, emaciated, fair-haired man, clad simply in a tattered shirt and worn-out breeches, gasping painfully for breath and lying on the ground in the shade of an enormous African tree (species unknown), while from a neighboring village of grass huts a charitable black-skinned woman is approaching him with a calabash full of pure cold water—a simple draft which, according to himself, seems to have effected a miraculous cure.

The Central Sudan, on the other hand, is represented to me by a very different picture: that of a self-confident and keen-eyed person, in a long cloak and wearing a turban on his head, riding slowly toward a gate in the mud walls of an African city, from which an excited population is streaming out to behold the wonder—Dr. Barth, the protégé of Lord Palmerston and subsidized by the British Foreign Office, approaching Kano, which no European eye had seen till then, but where forty years later my friend Sir Hugh Clifford, the Governor of Nigeria, traveled in state in a day to open a college!

I must confess that I read that bit of news and inspected the many pictures in the illustrated papers without any particular elation. Education is a great thing, but Dr. Barth gets in the way.

Neither will the monuments left by all sorts of empire-builders suppress for me the memory of David Livingstone. The words Central Africa bring before my eyes an old man with a rugged, kind face and a clipped gray mustache, pacing wearily, at the head of a few black followers, along the reed-fringed lakes toward the dark native hut on the Congo headwaters in which he died, clinging in his very last hour to his heart's unappeased desire for the sources of the Nile.

That passion had changed him in his last days from a great explorer into a restless wanderer, refusing to go home any more. From his exalted place among the blessed of militant geography and his memory enshrined in Westminster Abbey, he can well afford to smile without bitterness at the fatal delusion of his exploring days, a notable European figure and the most venerated, perhaps, of all objects of my early geographical enthusiasm.

A SCHOOLBOY PROPHECY REALIZED

Once only did that enthusiasm expose me to the derision of my schoolboy chums. One day, putting my finger on a spot in the very middle of the then white heart of Africa, I declared that some day I would go there.

My chums' chaffing was perfectly justifiable. I myself was ashamed of having been betrayed into mere vaporing. Nothing was further from my wildest hopes. Yet it is a fact that, about eighteen years afterwards, a wretched little stern-wheel steamboat I commanded lay moored to the bank of an African river.

Everything was dark under the stars. Every other white man on board was asleep. I was glad to be alone on deck, smoking the pipe of peace after an anxious day. The subdued thundering mutter of the Stanley Falls hung in the heavy night air of the last navigable reach of the Upper Congo, while no more than ten miles away, in Reshid's camp, just above

the falls, the yet unbroken power of the Congo Arabs slumbered uneasily. Their day was over.

Away in the middle of the stream, on a little island nestling all dark in the foam of the broken water, a solitary little light glimmered feebly, and I said to myself with awe, "This is the very spot of my boyish boast."

A great melancholy descended on me. Yes; this was the very spot. But there was no shadowy friend to stand by my side in the night of the enormous wilderness, no great haunting memory, but only the unholy recollection of a prosaic newspaper stunt and the distasteful knowledge of the vilest scramble for loot that ever disfigured the history of human conscience and geographical exploration. What an end to the idealized realities of a boy's daydreams!

I wondered what I was doing there, for indeed it was only an unforeseen episode, hard to believe in now, in my seaman's life. Still the fact remains that I have smoked a pipe of peace at midnight in the very heart of the African Continent, and felt very lonely there.

NO LONELINESS AT SEA

But never so at sea. There I never felt lonely, because there I never lacked company—the company of great navigators, the first grown-up friends of my early boyhood. The unchangeable sea preserves for one the sense of its past, the memory of things accomplished by wisdom and daring among its restless waves.

It was those things that commanded my profoundest loyalty, and perhaps it is by the professional favor of the great navigators, ever present to my memory, that, neither explorer nor scientific navigator, I have been permitted to sail through the very heart of the old Pacific mystery; a region which even in my time remained very imperfectly charted and still remote from the knowledge of men.

It was in 1888, when in command of a ship loading in Sydney a mixed cargo for Mauritius, that one day, all of a sudden, all the deep-lying historic sense of the exploring adventures in the Pacific surged up to the surface of my being.

Almost without reflection, I sat down and wrote a letter to my owners, suggesting that, instead of the usual southern route, I should take the ship to Mauritius by way of Torres Strait. I ought to have received a severe rap on the knuckles, if only for wasting their time in submitting such an unheard-of proposition.

I must say I awaited the reply with some trepidation. It came in due course, but instead of beginning with the chiding words, "We fail to understand, etc., etc.," it simply called my attention in the first paragraph to the fact that "there would be an additional insurance premium to pay for that route," and so on and so on. And it ended like this: "Upon the whole, however, we have no objection to your taking the ship through Torres Strait if you are certain that the season is not too far advanced to endanger the success of your passage by the calms which, as you know, prevail at times in the Arafura Sea."

I read, and in my heart I felt compunctious. The season was somewhat advanced. I had not been scrupulously honest in my argumentation. Perhaps it was because I never expected it to be effective. And here it was all left to my responsibility. My letter must have struck a lucky day in Messrs. H. Simpson & Sons' offices—a romantic day.

I won't pretend that I regret my lapse from strict honesty, for what would the memory of my sea life have been for me if it had not included a passage through Torres Strait, in its fullest extent, from the mouth of the great Fly River, right on along the track of the early navigators.

THE VOYAGE THROUGH THE TORRES STRAIT

The season being advanced, I insisted on leaving Sydney during a heavy southeast gale. Both the pilot and the tugmaster were scandalized by my obstinacy, and they hastened to leave me to my own devices while still inside Sydney Heads.

The fierce southeaster caught me up on its wings, and no later than the ninth day I was outside the entrance of Torres Strait, named after the undaunted and reticent Spaniard who in the seventeenth century first sailed that way without knowing where he was; without suspecting he had New Guinea on one side of him and the whole solid Australian Continent on the other (he thought he was passing through an archipelago), the

Photograph by Captain Frank Hurley

TORRÈS STRAIT BY MOONLIGHT

Between the island of New Guinea and the northeastern peninsula of Australia runs this reef-strewn passage, some eighty miles in width, a water lane of terror to the mariner (see text, page 272).

strait whose existence for a century and a half had been doubted, argued, squabbled about by geographers, and even denied by the disreputable but skillful navigator Abel Tasman (who thought it was a large bay), and whose true contours were first laid down on the map by James Cook, the navigator without fear and without reproach, the greatest in achievement and character of the later seamen fathers of militant geography.

If the dead haunt the scenes of their earthly exploits, then I must have been attended benevolently by those three shades—the inflexible Spaniard, of such lofty animus that in his report he disdains to say a single word about the appalling hardships and dangers of his passage; the pig-headed Hollander who, having made up his mind that there was no passage there, missed the truth by only fifty miles or so; and the great Englishman, a son of the soil, a great commander and a great professional seaman, who solved that question, among many others, and left no unsolved problems of the Pacific behind him. Great shades, all friends of my youth!

DEAD SHIPS IN TORRES STRAIT

It was not without a certain emotion that, commanding very likely the first and certainly the last merchant ship that carried a cargo that way, from Sydney to Mauritius, I put her head at daybreak for Bligh Entrance and packed on her every bit of canvas she could carry.

Windswept, sunlit, empty waters were all around me, half veiled by a brilliant haze. The first thing that caught my eye upon the play of green white-capped waves was a black speck marking conveniently the end of a low sand bank. It looked like the wreck of some small vessel.

I altered the course slightly in order to pass close, with the hope of being able to read the letters on her stern. They were already faded. Her name was *Honolulu*. The name of the port I could not make out. The story of her life is known by now to God alone, and the winds must have drifted long ago around her remains a quiet grave of the very sand on which she had died.

Thirty-six hours afterwards, of which about nine were spent at anchor, approaching the other end of the strait, I sighted a gaunt, gray wreck of a big American ship lying high and dry on the southernmost of the Warrior Reefs. She had been there for years. I had heard of her. She was legendary. She loomed up a sinister and enormous *memento mori,* raised by the refraction of this serene afternoon above the far-away line of the horizon drawn under the sinking sun.

And thus I passed out of Torres Strait before the dusk settled on its waters.

Just as a clear sun sank ahead of my ship, I took a bearing of a little island for a fresh departure, an insignificant crumb of dark earth, lonely, like an advanced sentinel of that mass of broken land and water, to watch the approaches from the side of the Arafura Sea. But to me it was a hallowed spot, for I knew that the *Endeavour* had been hove to off it in the year 1762 for her captain, whose name was James Cook, to go ashore for half an hour. What he could possibly want to do I cannot imagine. Perhaps only to be alone with his thoughts for a moment.

The dangers and the triumphs of exploration and discovery were over for that voyage. All that remained to do was to go home; and perhaps his great and equable soul, tempered in the incessant perils of a long exploration, wanted to commune with itself at the end of its task.

It may be that on this dry crumb of the earth's crust which I was setting by compass he had tasted a moment of perfect peace. I could depict to myself the great seaman navigator, a lonely figure, in a three-cornered hat and square-skirted laced coat, pacing to and fro slowly on the rocky shore, while in the ship's boat, lying off on her oars, the coxswain kept his eyes open for the slightest sign of the captain's hand.

Thus the sea has been for me a hallowed ground, thanks to those books of travel and discovery which had peopled it for me with unforgettable shades of the masters in the calling which in a humble way was to be mine, too—men great in their endeavor and in hard-won successes of militant geography; men who went forth, each according to his lights and with varied motives, laudable or sinful, but each bearing in his breast a spark of the sacred fire.

BEYOND THE CLAY HILLS

An Account of the National Geographic Society's Reconnaissance of a Previously Unexplored Section in Utah

By Neil M. Judd

Leader of the National Geographic Society's Pueblo Bonito Expeditions

AMONG my fellow-members of the National Geographic Society there are very few, I fancy, who have even thought of the possibility that these United States of the 20th century may have escaped thorough exploration; yet the fact remains that areas still exist—relatively small areas when compared with their parent States—about which little or nothing is definitely known. They remained in hiding when "the last frontier" was pushed westward into the Pacific.

Such neglected areas require no second Lewis and Clark Expedition. Their conquest would seem as child's play to those mountain men who trailed through the Rockies over one hundred years ago, or to those pioneers who braved the unknown in the late forties, seeking new homes on the Oregon and California coasts. Kit Carson lived to watch the Old West fade into the dust of endless immigrant trains; Jim Bridger retired to his little farm near Taos, New Mexico, about 1832 because the Great Interior Basin had become too thickly populated and trapping was no longer worth the effort.

The latest United States map* embodies a wealth of diverse information garnered from sundry sources. It pictures winding blue rivers and the red threads of a vast interlocking network of railroads and interurban lines; it locates cities, towns, and mere filling stations; it traces transcontinental highways and many local roads that are utterly impassable following the midsummer rains, and it also discloses to the searching eye certain isolated districts that exhibit none of those symbols which denote the passing of man on his conquests.

For the most part, these latter districts were left bare simply because the mapmaker could obtain no reliable information with which to relieve their bareness; they are, with few exceptions, areas which have never supported a surveyor's transit—areas which are still practically unknown and unexplored.

AN UNKNOWN LAND IN THE HEART OF OUR SOUTHWEST

One such area borders the Rio Colorado in Utah. East and west from this savage red river unmapped mesas stretch away mile after barren mile to green mountains, overtopping an endless distance of pink and white and brown sandstone. Through these thousand-foot layers of solid rock tireless streams have carved for eons, each widening and deepening its pathway to the sea. And man in his wanderings has occasionally followed these same paths, avoiding the blistered table-lands between.

Securely guarded by the deep gorges of the Rio San Juan and the Colorado lies the least-known section, perhaps, of this gigantic rock-floored region. It remains a veritable *terra incognita*. A few adventurers have brushed its more accessible corners, for we find their rusted camp kettles and hear indirect tales of their comings or goings, but they left no permanent record of their individual journeys to aid the topographer or the historian.

Because of the mystery wrapped about it; because, seemingly, it had been so purposely avoided; because all trails led around and none through it, this particular region, nestling in the elbow of the great Colorado, held a peculiar fascination for me. Back in 1907, while searching

* "United States of America," in five colors, published by the National Geographic Society as a map supplement with the National Geographic Magazine for April, 1923. Size, 38 x 28 inches. Additional copies, paper, $1.00; linen, $1.50.

NATIONAL GEOGRAPHIC SOCIETY REPRESENTATIVES READY FOR THE START FOR KAYENTA

George B. Martin, Edwin L. Wisherd, and the writer, as they left Gallup, New Mexico, for Kayenta, outfitting point for the San Juan Expedition.

Photograph by Edwin L. Wisherd

THE EXPEDITION'S PACK-TRAIN LEAVING KAYENTA

Photograph by Neil M. Judd

DESERT TRAILS ARE OFTEN LONG AND WEARY, WITH THE HORIZON SEEMINGLY FIXED IN ITS DISTANCE

the shadows of White Canyon for footprints of the ancient cliff-dwellers, I had gazed southward across its silent, shimmering expanse. Again, in 1909, accompanying Dean Byron Cummings to the discovery of the incomparable Rainbow Natural Bridge* (see pages 298 and 299), this same untamed district, when viewed from the gray slopes of Navajo Mountain, had lost none of its inherent mystery and charm.

AGREES TO CARRY THE SOCIETY'S BANNER ALONG UNTRODDEN TRAILS

Still a decade later, from ridges that neighbor Kaiparowits Plateau and the Circle Cliffs, far to the west, that siren something which tempts desert pilgrims from their appointed way beckoned me toward the grim silence and the elusiveness of this unknown canyon country. The desert possesses an impelling force—an indescribable force, infinitely magnified with greater distance and isolation from the usual haunts of men.

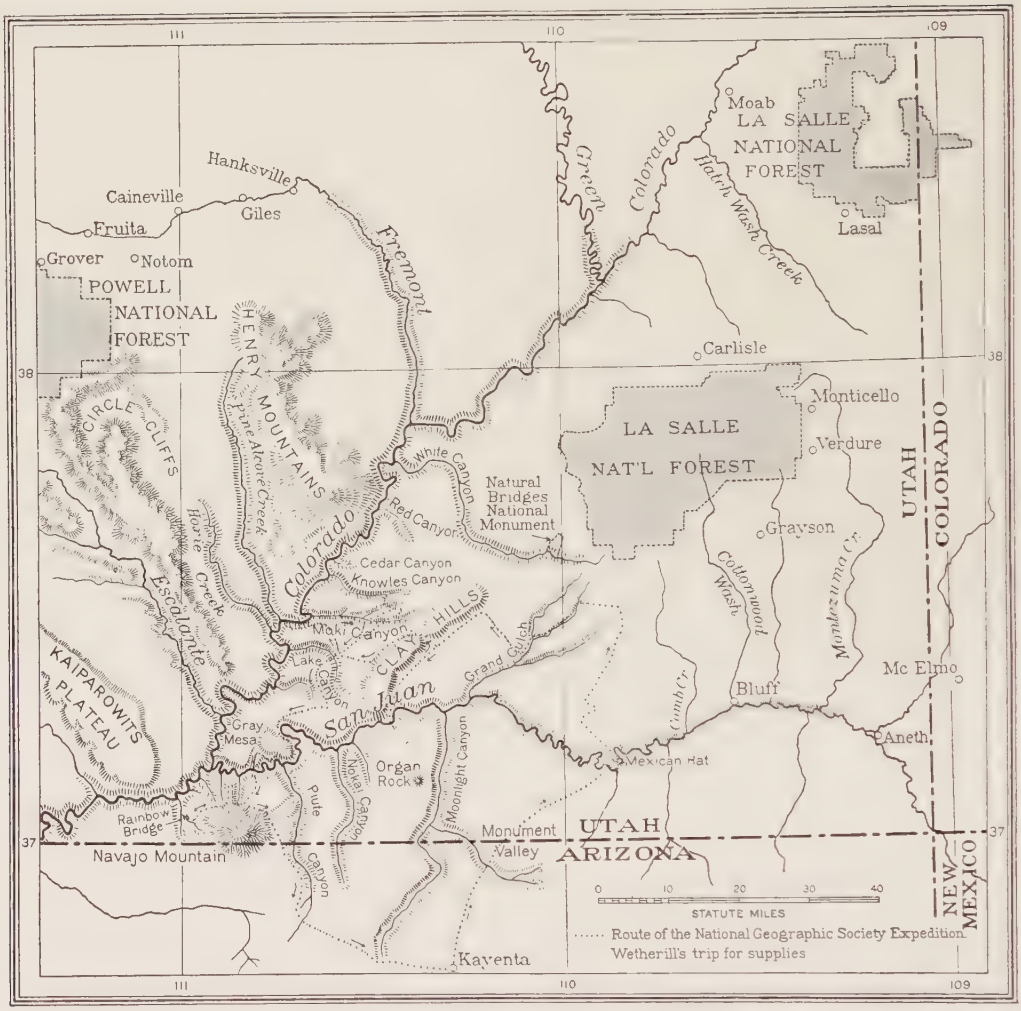
So it was with a strange mingling of secret satisfaction and dubiousness that I accepted the National Geographic Society's recent invitation to carry its banner yet farther along untrodden trails.

This unfrequented section in the angle of the Colorado and San Juan rivers boasts one upstanding landmark, the Clay Hills. Viewed from the south and east, the Clay Hills rise as an unscalable barrier of blue and gray shales and sheer sandstone cliffs. A single narrow gateway leads through and beyond this barrier.

From their cedar-crowned heights the Clay Hills slope gently down to the west, where lies the invisible gorge of the Rio Colorado; thence miles of pale yellow sand lift themselves slowly to meet a skyband of far-away cliffs, dimly purple through the distance. It is indeed a wild country and lonesome. Its very wildness adds to its solitude, as the latter emphasizes its awful vastness.

Here, in an area larger than the State of Connecticut, there resides no living soul. The silence hangs heavily. Roving, four-footed beasts of the desert are

* See, in the NATIONAL GEOGRAPHIC MAGAZINE, "The Great Natural Bridges of Utah," by Byron Cummings, February, 1910; "The Great Rainbow Natural Bridge of Southern Utah," by Joseph E. Pogue, November, 1911, and "Encircling Navajo Mountain With a Pack-Train—a New Route to Rainbow Natural Bridge," by Charles L. Bernheimer, February, 1923.



Drawn by A. H. Bumstead

A SKETCH MAP SHOWING THE ROUTE OF THE NATIONAL GEOGRAPHIC SOCIETY'S SAN JUAN EXPEDITION

rarely seen; yet their tracks, printed sparingly in the sand, recount the world-old story of the survival of the fittest—a soft-padded night prowler has found its prey and won an easy victory.

Even the birds seem to have deserted this strange country, for one sees but few, other than those noisy jays of the cedar ridges and the buzzards, circling ceaselessly in a turquoise sky.

MORMONS ONCE CROSSED THE REGION

Nearly half a century ago a band of Mormon colonists, guided by Piute Indians, who were later disowned, cut a bold path from western Utah, across the Rio Colorado and the Clay Hill divide, to the founding of Bluff. Descendants of the cattle these pioneers drove now forage the more favored uplands for an uncertain existence, but no trails lead westward into the deeper, more forbidding canyons.

Seekers after gold and, but recently, Government engineers have followed in the way of the indefatigable Powell, braving the whirlpools and rapids of the Colorado, climbing from its dark waters into the gaping mouths of its larger tributaries. But each had his own particular mission and did not wander far afield.

Our unexplored desert areas are savage, cruel, and unmerciful, however

Photograph by Edwin L. Wisherd

SHIFTING YELLOW AND ORANGE-COLORED SANDS IN MONUMENT VALLEY

Against a background of red cliffs and purple shadows, an Indian, in the middle distance, is resting on the trail across the dunes.

warmly they seem to welcome the newcomer. A single human life is as a grain of wind-blown sand—it comes, rests awhile, drifts on. And often, no doubt, the desert gods smile knowingly with each such passing.

At a San Juan ford some seventeen years ago I met a grizzled prospector with an unhurried burro, bound for the Henry Mountains. The Government maps he carried were recent and encouraged him, because they represented neither intervening hills nor valleys, to believe that his trail was an easy one, with no obstacles other than the Colorado itself.

Neither the old man nor his diminutive mule was ever seen again; both were sacrificed on the altar of those insatiable forces that rule the open spaces.

ONCE THE HOME OF PREHISTORIC PEOPLES

But, however deserted and silent this untamed country may seem to us, there was a time, uncounted centuries ago, when human voices echoed through the dark recesses of the canyons; when sandaled feet stalked deer and mountain sheep along their rocky rims. The crumbling walls of crude stone dwellings, blending chameleon-like with the variegated colors of the cliffs against which they cling, mark the temporary homes of prehistoric peoples.

Fragments of ancient pottery and flint chips discarded by the arrow-maker snap under foot as one climbs the talus to some yawning cave. And there, in the cool shadows, one observes the scattered ashes of former camp fires, the angular wall drawings of primitive artists (see illustration, page 290), and daubs of mud thrown against a cavern roof by children at play.

These ancient folk, safely cloistered in murky canyons, tarried but a short while; then moved on to a happier environment. Perhaps they, too, felt the crushing power of this lonesome land!

To neighboring Indians of to-day the uninhabited region west of the Clay Hills is a fearful place, the home of all-powerful, unseen forces. With the mountain sheep gone and the deer fast disappearing, few Navajo can be induced to venture

Photograph by Edwin L. Wisherd

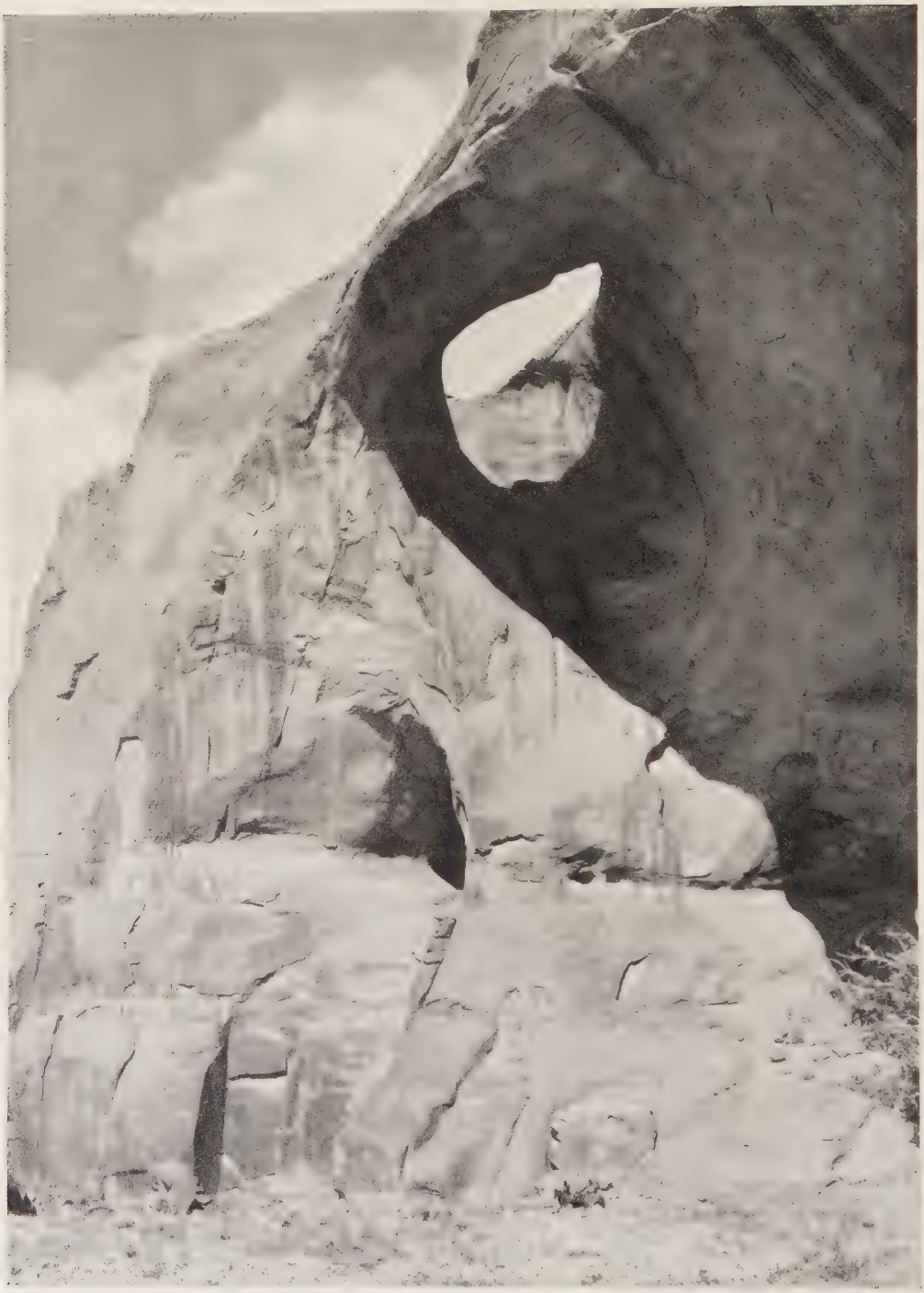
MONUMENT VALLEY, PLAYGROUND OF THE DESERT GODS

Here man is made to feel his comparative insignificance. Note the rider on the cliff in the middle foreground.

Photograph by Edwin L. Wisherd

WIND-BLOWN SAND HAS BEEN THE SCULPTOR AND TUNNEL BUILDER HERE: MONUMENT VALLEY, NORTHERN ARIZONA

In the land of the red rocks one finds many weird fancies to excite one's wonder and increase one's awe (see also illustrations on pages 282 and 283).



Photograph by Edwin L. Wisherd

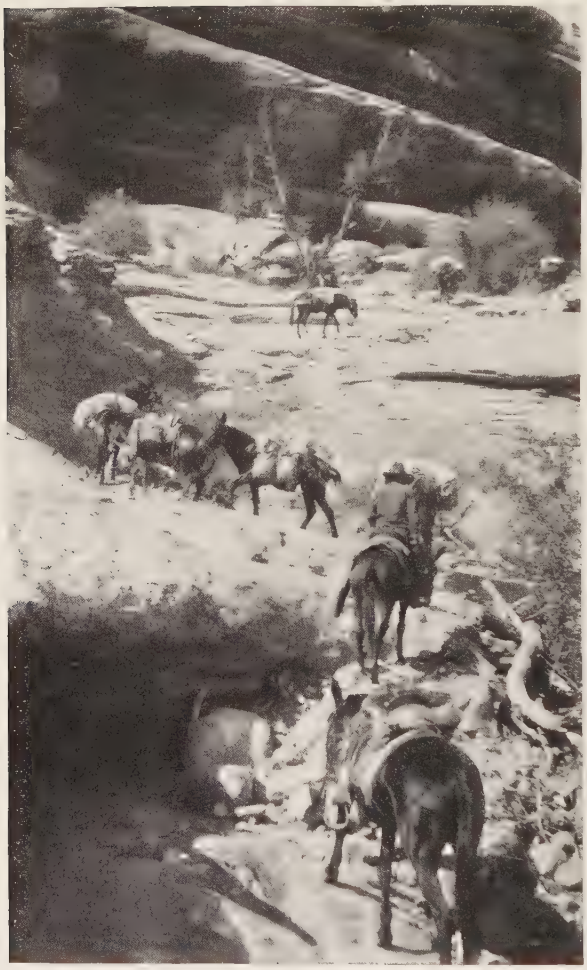
WIND AND SAND AND WATER HAVE JOINED FORCES IN AN EFFORT TO BREAK DOWN THE STONE BARRIERS SURROUNDING MONUMENT VALLEY

(SEE MAP, PAGE 278)

Photograph by Edwin L. Wisherd

CARRIED ON THE BREATH OF CEASELESS WINDS, THE FINE YELLOW SAND CARVES STRANGE WINDOWS IN THE RED WALLS OF MONUMENT VALLEY

(SEE ALSO PAGE 279)



Photograph by Neil M. Judd

THE EXPEDITION'S PACK-TRAIN IN GRAND GULCH
(SEE ALSO PAGE 285)

north of the Rio San Juan. The old warrior who was to have accompanied us on the reconnaissance slipped away to hide among the tall rocks on the very eve of our departure; a second Navajo failed to overtake our party on the trail, as he had promised to do.

FLOOD WATERS NECESSITATE DETOUR BY THE EXPEDITION

When we left Kayenta, early last October, the Arizona sands were still soaked with unseasonable and most unwelcome rains. Flood waters were racing down the San Juan. To have attempted to swim the river, as we had planned to do, would have been the height of folly. So we cut the number of our pack-mules to twelve, loaded seven of them with oats, and started for the swinging bridge near Mexican Hat. Because canyon trails are sometimes rough and accidents do happen, one extra mule was included in the train.

Four mules carried just enough rice and flour and coffee and bacon to assure each of us two meals a day for thirty days; and, since the law of brute force rules that strength shall prevail, it was mutually understood that that member of the party too ill at any time to reach for his biscuit and bowl of rice would find himself in an unfortunate predicament, to say the least. There was to be no breakfast in bed on this trip!

Among all the dude parties that have fared forth from Kayenta, none, perhaps, was so thoroughly mulified as ours. There were twelve pack-mules, biting and kicking and jockeying for position as loaded mules always will do when leaving the home corrals. Then there were four of us, and each sat astride a mule of untested individual habits, with shoulders hunched against a cold, drizzling rain that added nothing of joy to the early miles of our prospective journey.

Out in front, leading the pack-train, rode John Wetherill, guide extraordinary and master of the whole plateau country. Wetherill and I had ridden the desert trails together on other occasions, and I knew the mettle of the man. Where he started, there he went, if humanly possible to do so. And we were starting from Kayenta for a little ride beyond the Clay Hills, where few, if any, had ridden before (see map, page 278).

Forced from our intended path by unexpected floods, we trailed through Monument Valley, playground of the desert gods, and across endless mesas to the Rio San Juan. Even in October the valley was oppressively hot, with the midday sun flung smartly back from the shifting yellow sand.

Wind and sand and water have here been locked in ceaseless rivalry since the world was young. Hundreds of square miles of solid rock have been worn and washed away, leaving a rear guard of lofty red buttes pointing majestically toward the blue heavens. Here the elements have battled for superiority, and the wreckage of their long-continued strife is both a monument to the tremendous forces of Nature and a convincing reminder of the inconsequential capabilities of mere man.

Photograph by Neil M. Judd

DURING TWO LONG DAYS THE PARTY FOLLOWED THE TORTUOUS STREAM COURSE OF THIS ROCK-WALLED "DITCH" (GRAND GULCH)

Out of it an old Indian trail led over the rim toward the Clay Hills.

A PERILOUS TRIP FOR SUPPLIES

Ten days and 150 miles of trail brought us to a dripping seep on the west rim of Grand Gulch, with the red wall of the Clay Hills standing out boldly a short day's ride away. From this camp Wetherill turned down to the San Juan for a half ton of oats which Indians had agreed to deliver there. But he found no cache at the crossing and no recent signs of horses or men.

Realizing the Navajo had again failed us and cognizant of the hazard of proceeding farther without additional grain for the mules, Wetherill crossed the always treacherous river on a log; then, guided by the stars, walked 20 miles to a borrowed flivver and continued to Kayenta (see route, page 278). Our relief train had started on schedule, but had turned aside en route to attend a squaw dance; thereafter the urgencies of our expedition were forgotten.

Three days later Wetherill was back at the ford, with the much-needed grain and a new recruit. We never inquired how he had persuaded the Indian to accompany him, although we noticed that the Navajo feigned sudden and serious illness as soon as he learned just where we intended going. But we had burro steaks for supper that night, and after a full meal the native gave an attentive ear while we expressed the hope that he would cancel any business engagements he had made for the next few days and continue with our party.

However dubious Cauz-zus-see may have been as to the wisdom of our venture,

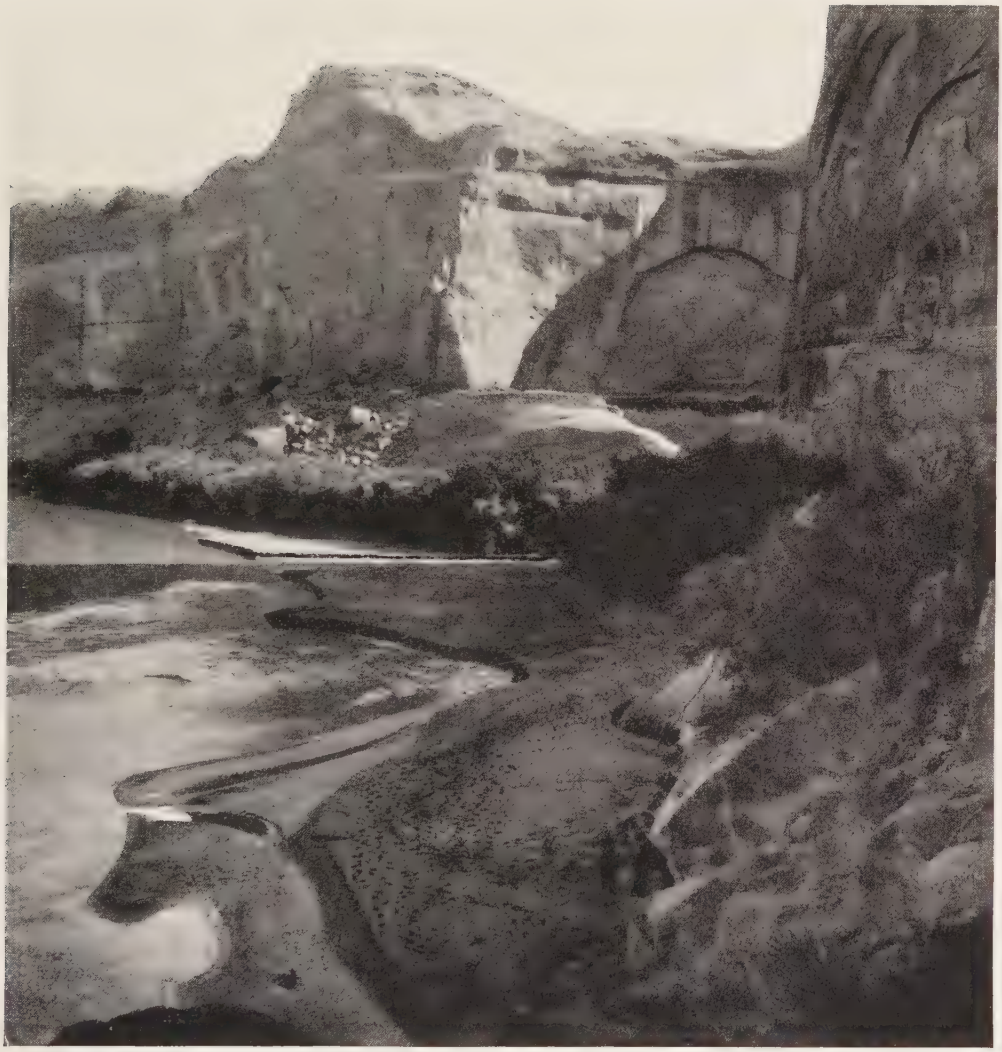
WHERE THE CLAY HILLS MEET THE RIO SAN JUAN

An unscalable barrier of many-colored clays and sandstones rising over 1,000 feet above the water. The pack-train was driven across the steep talus and down river for four miles to meet Wetherill returning with supplies (see text, page 285).

Photographs by Edwin L. Wisherd

BEYOND THE CLAY HILLS

Sand and sandstone reach out to meet the distant sky.



Photograph by Edwin L. Wisherd

WHERE MOKI CANYON JOINS THE RIO COLORADO

The "Silvery Colorado" is a dull red flood which carries heavy tribute of sand and clay from the four plateau States to the Gulf of California.

he soon proved a faithful and willing assistant. Personally familiar with only a small portion of the wild region beyond the Clay Hills, he yet retained vivid pictures of it as orally painted by older men. He found water in most unpromising places; he knew odd corners where our weary mules might graze contentedly for a night; but, somehow, his joy increased in direct proportion to the speed with which we traveled.

And when, a few days after we had forded the San Juan on our homeward journey, Cauz-zus-see galloped away light-hearted and happy to his hogan and family, the tall cliffs echoed the sharp minor notes of his buoyant trail song. He had returned in safety from the dwelling place of Evil!

THE TRADITION OF FUNERAL PROCESSION TO THE HENRY MOUNTAINS

There is a dim, unverified tradition that the Navajo of old carried the bones of their dead warriors to a final resting place near the Henry Mountains. Elaborate

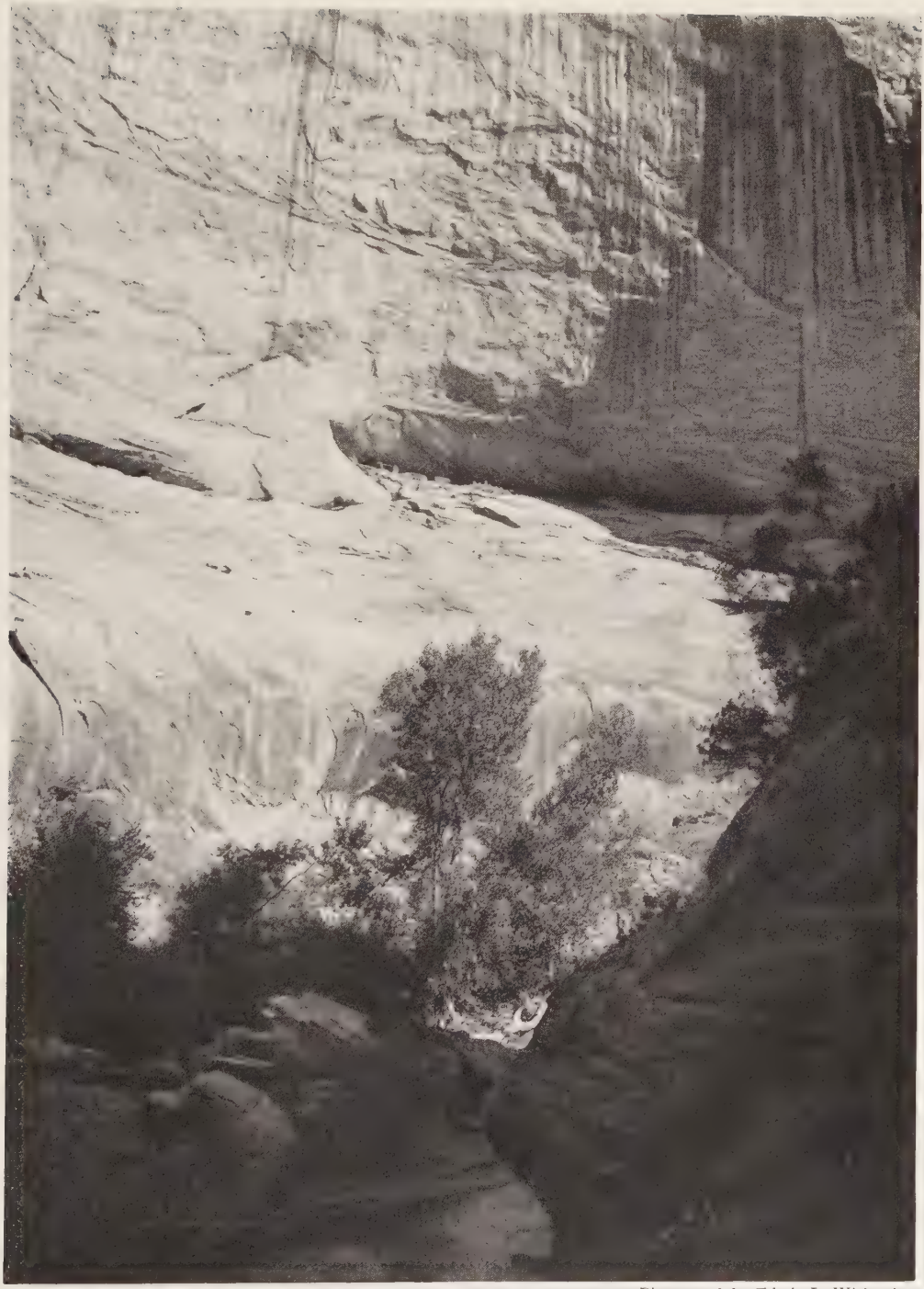
THE TWISTING WAY OF MOKI CANYON

The Expedition followed a winding path for 18 miles through this silent canyon. In the cave at the left is a cliff-dwelling, and below it a series of steps, pecked with stone hammers.

Photographs by Edwin L. Wisherd

PRIMITIVE MAN BUILT HIS HOMES IN THE GREAT CAVES

Those objects he lost or threw away hold much of his unwritten history. Note the mounted men at the edge of the cave shadow.



Photograph by Edwin L. Wisherd

AN ANCIENT RUIN IN MOKI CANYON

Like swallows, the prehistoric cliff-dwellers built cell-like homes high in the canyon wall, fairly secure from the attacks of Nature and their hereditary foes.

Photograph by Edwin L. Wisherd

PREHISTORIC ARTISTS, WITH A CLIFF FOR A CANVAS, DREW RED, WHITE, AND GREEN PICTURES OF ANIMALS AND SQUARE-SHOULDERED MEN IN WHAT IS NOW AN UNINHABITED LAND

ceremonies of prayer were enacted before crossing the San Juan and the Rio Colorado; other invocations were voiced as the carriers returned from their solemn mission. But these sacred rites are no longer performed; the requisite prayers have been lost with the fleeting years, for one-time bearers of the war shield are now few in number and their arrows lie broken.

If this suggested custom did in fact obtain in olden times, wherein lies its origin? Do the Navajo, in whose veins flows the blood of many captive peoples, trace some thread of their composite ancestry to the ancient cliff-dwellings that now crumble in the silent canyons far to the north? Strange places these and they prompt strange imaginings!

Prehistoric dwellings and the desert—they fit so well together! The desert appears to cherish those things which seem such an intimate part of it, and to reject speedily that which cannot know or understand its varying moods.

The great caves, with their abandoned camp sites, their storage cists, or their shattered ruins, tell a mute tale of human struggles long before the written history of our continent began.

On this journey beyond the Clay Hills we traversed canyons perhaps never before visited by white men; we crawled through narrow doors into dwellings no booted foot had previously entered; we climbed canyon walls on trails unused for centuries.

The ancient cliff-dweller was kin to the lizard; a series of shallow holes pecked in the sheer sandstone cliff was the ladder by which he scaled prodigious heights. The unwatered, sun-lit mesas, the shadowy canyons—he took these for home and hunting ground.

But prehistoric man did not dwell long in the parched country west of the Clay Hills. His habitations there were mostly crude affairs; he built no colossal structures such as Pueblo Bonito* and Pueblo del Arroyo. Perhaps he realized the utter impossibility of conquering a coun-

* See the NATIONAL GEOGRAPHIC MAGAZINE for June, 1921; March, 1922, and July, 1923.

Photograph by Edwin L. Wisherd

A HUGE SAND DUNE FOLDED DOWN OVER A 500-FOOT CLIFF

This afforded a safe though toilsome way out of Moki Canyon.

try which remains to-day, centuries later, almost as wild and untamed as he left it.

IN MOKI CANYON, PLACE OF DEATH

Before starting on the recent reconnaissance we had been able to learn but little of the Clay Hills country, and that little later proved mostly to be erroneous. Moki Canyon, for instance, was represented as about five miles long and enterable, on foot only, in but two places. By boat, it was said, one could reach the slit through which Moki joins the Colorado; eastward, where a huge sand dune folds down over the rim rock, one could slide to the bottom of the gorge.

We made three camps in Moki Canyon, the last fully 18 miles above its mouth and perhaps two-thirds of its total length; we discovered old Indian trails—made, no doubt, by Navajo or Piute hunting parties—and took our mules up both the north and south cliffs. But this was not altogether easy; at times, indeed, it was a bit breath-taking.

Then, too, mules can be such perverse creatures. They will stop on the very edge of nothing at all to pluck a tuft of withered grass, with no thought for their companions, who may be holding a more precarious footing just behind. Although prepared for accidents and fully expecting them, our party seems to have been especially favored by the desert gods. We gave the password and advanced without fear.

When the going was too rough even for the mules, we reconnoitered on foot. Then, finally, as the whole country seemed to close in upon us, our colleagues were sent back with the pack-train to our main cache, while Wetherill and I continued alone.

For days we climbed canyon walls and crossed tiresome mesas, whose weathered sandstone glistened in the sunshine like whitecaps at sea. It is indeed a wild sort, this land beyond the Clay Hills, and destined always to remain so.

Once, in Moki Canyon, I noticed Wetherill check his horse suddenly; then press close to the left bank, as he circled a sheet of smooth, velvet sand beside a boulder that almost blocked the stream bed. Drawing quickly to one side and splitting the pack-train, I watched, with bated

Photograph by Edwin L. Wisherd

THE HENRY MOUNTAINS FROM NEAR THE HEAD OF MOKI CANYON

The Navajo are said to have taken the bones of their dead warriors across these barren wastes to a final resting place near the distant mountains (see text, page 287).

Photograph by Edwin L. Wisherd

THE EXPEDITION'S PACK-TRAIN "SNAKING" THROUGH THE SANDSTONE LEDGES THAT STRETCH OUT FROM THE BASE OF NAVAJO MOUNTAIN

Photograph by Edwin L. Wisherd

WHEN THE WAY IS SLOW AND THE TRAIL IS HARD

breath, the sandy basin grow more liquid and more elastic as each animal crossed.

Only Wetherill and the Indian sensed the full strength of those devils that lay waiting in that bed of quicksand. Two short spans to the right, and mule or man would have been clasped in a viselike grip of unbelievable power.

Moki Canyon, place of the dead! Like the Venus flytrap (*Dionœa muscipula*), whose sticky leaves fold down upon the fluttering wings of a careless insect, the quicksands of Moki Canyon patiently wait to embrace the blind or heedless passer-by.

Under the quick steps of our mules, those treacherous sand pockets swayed and stretched like huge sheets of yellow dental rubber; beneath each thin, vibrant surface lay slow, cruel death for the unrescued. But we went through—the first pack-train to dare—through 18 miles of it, building trail when necessary, accepting risks that could not be avoided, curious as to what the next mile would disclose.

We had other experiences with quicksand, the last while fording the Rio San Juan on our homeward way. In this latter struggle Bino was the principal actor. Bino, the Beautiful! He was a wild little devil of reddish-brown color and he could kick you twice before you could get out of his way. His was a double-barreled attack. No one ever saw him raise those quick hind feet or put them down again. He just kicked, kicked twice, and, when necessary, he repeated.

THE STORY OF BINO, THE BEAUTIFUL

The trail we were following had been made by hunting parties in those glorious days when game was plentiful; when Navajo and Piute warriors, in a friendly sort of way, used to steal each other's women. The trail circled the south edge of Gray Mesa, wound through ragged canyons, and then dropped—I cannot recall that last thousand feet—dropped to the very edge of the drab, brutal river.

Cauz-zus-see was sent in to "feel" the crossing. He walked up and down, back and forth, in the icy waters; they were about four feet deep. Now and then he jigged a bit, testing soft spots his feet searched out. Quicksand could not be avoided entirely, but the safest path was marked. Straight across to the big riffle,

Photograph by Edwin L. Wisherd

ON THE TRAIL TO RAINBOW NATURAL BRIDGE

Where Nature builds fences Man walks antlike along their tops to reach forbidden fields beyond. Kaiparowits Plateau (see map, page 278) shows dimly in the distance.

then down current with it, gradually seeking the shore!

The mules were bunched and crowded in, close on the heels of the Indian's horse. Cold, muddy water chilled their flanks and rolled up against their heavy packs, but on they pressed, seeking to escape the unfamiliar shouting and swinging of ropes at their rear. There was a degree of frightened plunging, of snorting and throwing of water, as mule after mule broke through the thin river bed and struggled on.

Then Bino went down, both forefeet at once. He squealed in fright and jerked back; the waves bowled him over; and with head under water he splashed and flopped and floundered around until shortly his efforts ceased and he floated on with the heavy current.

Help for the red mule just then was impossible. The other animals were already in the main channel, with liquid sand underfoot. Better lose one than a dozen, even though the lost mule did carry every cup of flour in the outfit! Wetherill hesitated a bare second; then, with a savage yell, forced his black horse against the stragglers. These lunged forward, crowding closely upon the Indian, as he guided them to shallow water and a boulder-strewn bar left by the summer's floods.

But Bino had one kick left! He delivered this as his trail companions neared the sheltering south shore. At a shout, the Navajo rushed back and pulled the mule's head above water; willing hands soon loosed the ropes and carried the soaked pack ashore piecemeal. The half-drowned creature was too weak to stand without aid, yet he blew spray like a sulphur-bottom whale.

A few moments later, when he went down again and floated out to the end of his hackamore, he was literally towed to the water's edge, set on his feet, and roundly cursed, however dejected and bedraggled he appeared at the moment. Bino was no longer beautiful!

Our flour was thoroughly wet and one sack had been lost; Bud's bed was drenched and mud-soaked; and there was not even a kodak to witness the crossing!

Photograph by Neil M. Judd

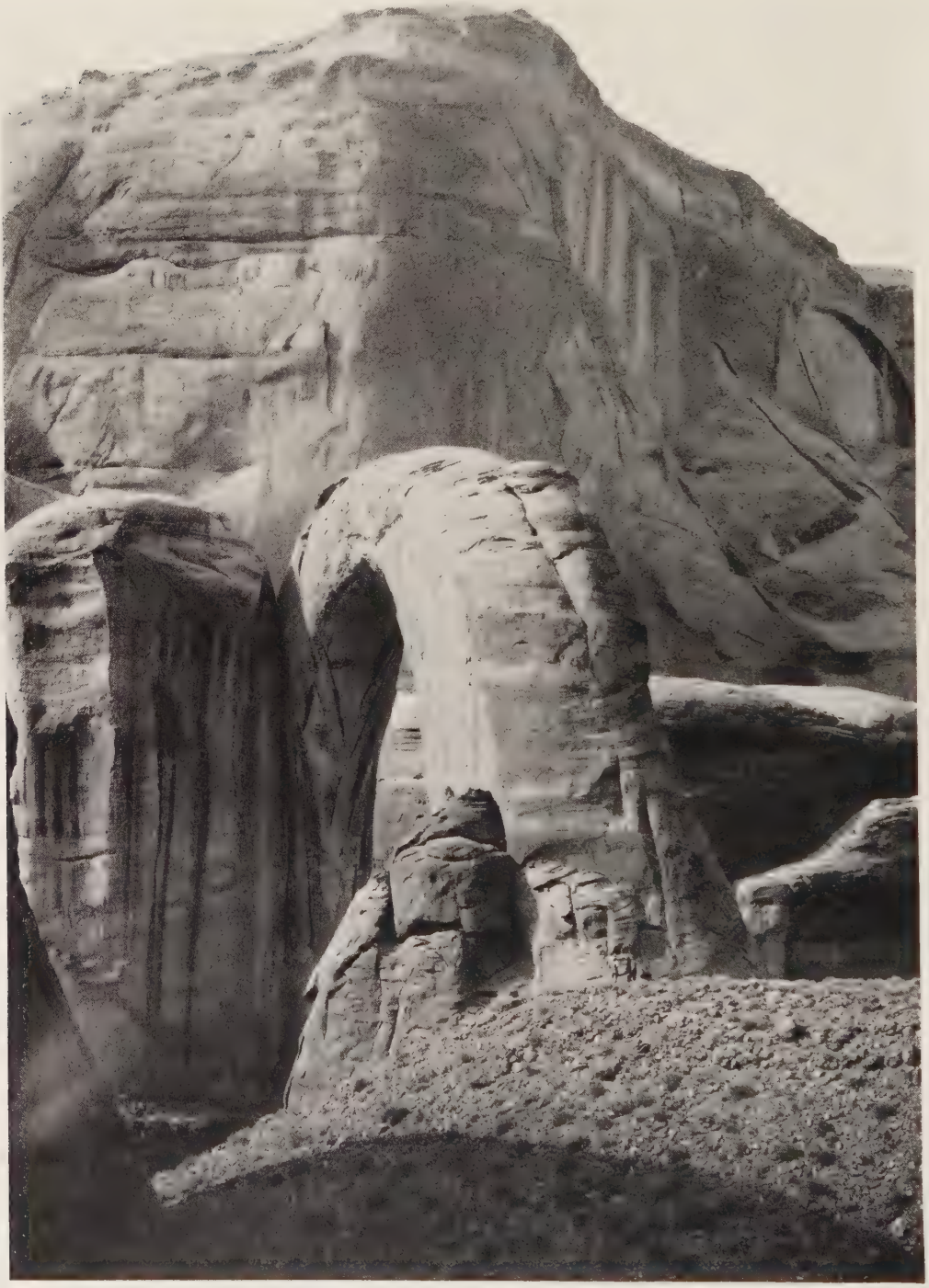
ALONG A NARROW PATH IN BRIDGE CANYON

On the way to Non-ne-zo-shi bo-ko, canyon of the stone rainbow.

SURPRISE VALLEY

Photograph by Edwin L. Wisherd

Made famous through the writings of Zane Grey, this spot offers the most restful and refreshing camp ground between Kayenta and the Rainbow Bridge.



Photograph by Edwin L. Wisherd

THE RAINBOW NATURAL BRIDGE

The men standing at the upper base of the great arch afford some slight conception of its massive proportions; yet the "bridge" is dwarfed by the walls of the canyon itself. Devout Indians will not pass beneath the arch without saying prayers to their Supreme Being.

Photograph by Edwin L. Wisherd

LOOKING THROUGH THE RAINBOW-TURNED-TO-STONE

According to Navajo mythology, a rainbow was here turned to stone, thus permitting certain hero gods to escape flood waters in the canyon. An ancient shrine still stands beneath the left-hand buttress. Note the man on the white rock in the gorge.

Photograph by Neil M. Judd

BASKET DANCE OF THE TEWA INDIANS

Each fall a "ceremonial" is held at Gallup, New Mexico, when neighboring Indian tribes join in friendly competition to determine not only which one presents the most beautiful native songs and dances, but also which village has made greatest progress in the crafts of the white man.

Always the pictures one especially desires are lost! This particular day was cloudy and dull and a misty rain was falling to prevent use of the cameras. But similar misfortune had greeted us so frequently before. Only the previous day, trailing along the thin edge of Gray Mesa, we glimpsed floating bits of most marvelous panoramas, screened by a dense fog that rode on the canyon winds and at times actually hid the guide from those who followed at the end of the pack-train.

What wonderful paintings were shielded from us on that bleak rim rock we may, perhaps, never know; but we could sense them. To the north the endless yellow vast, gutted by twisted canyons, we had but recently left behind; toward the south the broad bulk of Navajo Mountain, home of the gods, pivot on which many native legends turn; east and west reached the sheer canyon walls of the San Juan, with its sullen current coiling slowly and silently far below, like an arm of a gigantic octopus.

But when the clouds are heavy and hang low one cannot take pictures, and when the mules are in the quicksand one does not think of pictures, until afterward. And for this reason photographic records of exploration journeys are usually incomplete.

TRIALS AND DISCOMFORTS OF THE TRAIL

Never were rains more persistent than last year! They began in midsummer, which is proper, and continued until early November, which is not at all as it should be. At the very beginning of our expedition, high water in the San Juan forced a long eastward detour. Storm clouds camped with us frequently, and then, as if loath to see us leave, held us for days at Kayenta because a weary sun was too tired with constant drying out of mudholes.

Those transcontinental motorists who have waited dejectedly in a

AN INDIAN "POTATO RACE" AT GALLUP'S ANNUAL CEREMONIAL

Photograph by Edwin L. Wisherd

The winner is he who first carries a given number of potatoes, one at a time, a measured distance and deposits them in a pail at the goal.

wide adobe flat for help to come through the miles of mud have seen the Southwest at its wettest. There, summer showers are almost tropical in their intensity. They fill arroyo banks and undermine bridges while you wait. They loosen boulders, throw down trees, and start landslides; they add to the work and worry of riders.

But most trail accidents, if no serious injury is involved, sooner or later disclose humorous possibilities. The personal discomfort of one's saddle companions is always fit subject for jest. And during the rainy season, especially, opportunity knocks frequently.

Sodden biscuits are filling, if unpalatable; salted coffee can be drunk. To watch cold, clubby fingers build a fire with soggy wood is indeed amusing. But the very acme of trail humor follows when a tired rider reaches camp at nightfall to discover that his bed tarp has not protected his blankets from a penetrating shower. One can forgive human frailties and omissions, but when the gods take sides the joke is too good to disregard utterly.

There is the case of little Mac—flat-faced, lop-eared Macduff—slowest and most obstinate of all our pack-mules. We were climbing the south wall of the San Juan and our clothes were still drenched from the rescue of Bino; the trail was wet and steep and a bit tricky. In trying to make one particularly high jump, Mac struck the corner of his pack, fell backward, and rolled over. Stub caught him on the very edge of the precipice and sat on his head, while George climbed atop the prostrate mule to loose the lash rope.

Now there was nothing ludicrous about Mac's predicament at the moment; his hind feet were thrust out into empty air a good fifty feet above a jagged rocky talus. He was safe if one stubby cowpuncher could hold down his head and prevent his struggles while the bulky pack was removed and those dangling hind feet pulled back on to the trail.

No one was present to point a camera; all hands stretched to help the stubborn mule with the Scotch name. But afterward, on the easy mesa trail, when the strain of the rescue had vanished, much sport was made of Mac's narrow escape, of Stub sitting complacently on the mule's head, of George scrambling over the wet, muddy pack, tugging at the rain-stiffened ropes.

Two days later we stood beneath the graceful arch of the colossal Rainbow Natural Bridge (see pages 298 and 299), marveling at the stupendous folly of Nature, who builds temples to herself and then, in changeful mood, tears them down again. Low-hanging clouds bowled across the gorge to reveal, for seconds only, the glistening snow-covered summit of Navajo Mountain. Chill winds rushed down the canyon to cry and moan in the creviced red walls.

AT THE RAINBOW BRIDGE FOURTEEN YEARS AFTER ITS DISCOVERY

Fourteen years before I had first seen this sublime creation of the Master Builder. Following Professor Cummings, urged on and encouraged by John Wetherill after our Indian guides sought to quit their wearisome task, we had come, the first white men to gaze on the great Na-gee-lid Non-ne-zo-shi—the Rainbow-Turned-to-Stone. Those early memories, those initial impressions, still baffle description.

The trail of to-day is much easier than the one we built; its more dangerous portions have been smoothed out or avoided. Three hundred individuals, including the late ex-President Roosevelt and a score of travelers from abroad, have followed in the footsteps of the discoverer and few have returned disappointed. Not all of these strangers came with reverence in their hearts. One, for instance, seems to have had as his chief object in visiting Non-ne-zo-shi the opportunity to be able to tell his grandchildren that he was the first civilized man to drive a golf ball over the stately arch.

And so it was very gratifying to note, after these many years, that the Rainbow Bridge, alone among the natural wonders of our country, remains pretty much as the desert gods made it.

Majestic in its solitary retreat, yet dwarfed by the massive cliffs that tower above it, the stone rainbow is still the mystic bridge over which the true sons of Earth may escape their mortal sorrows. As a rule, the desert makes brother worshipers of all who venture into its secret places to share its hidden mysteries.

AMONG THE "CRATERS OF THE MOON"

An Account of the First Expeditions Through the Remarkable Volcanic Lava Beds of Southern Idaho

By R. W. Limbert

With Illustrations from Photographs by the Author

IN THE West the term "Lava Beds of Idaho" has always signified a region to be shunned by even the most venturesome travelers—a land supposedly barren of vegetation, destitute of water, devoid of animal life, and lacking in scenic interest.

In reality the region has slight resemblance to its imagined aspect. Its vegetation is mostly hidden in pockets, but when found consists of pines, cedars, junipers, and sagebrush; its water is hidden deep in tanks or holes at the bottom of large "blow-outs" and is found only by following old Indian or mountain sheep trails or by watching the flight of birds as they drop into these places to quench their thirst. The animal life consists principally of migrant birds, rock rabbits, woodchucks, black and grizzly bears; its scenery is impressive in its grandeur.

A glance at a map of Idaho shows that the southern part of the State, lying between Arco and Carey and north of Minidoka, is a vast region labeled desert or rolling plateau.

Although almost totally unknown at present, this section is destined some day to attract tourists from all America, for its lava flows are as interesting as those of Vesuvius, Mauna Loa, or Kilauea.

The district consists of some 63 volcanic craters, lava, and cinder cones, all at present extinct or dormant. The largest and most conspicuous is 600 feet high, rising in the midst of a belt of craters two or three miles wide and 30 miles long. The craters or cones are close together in the north and west; in the south they are miles apart.

That a region of such size and scenic peculiarity, in the heart of the great Northwest, could have remained practically unknown and unexplored is extraordinary.

For several years I had listened to stories told by fur trappers of the strange things they had seen while ranging in this region. Some of these accounts seemed beyond belief.

I had made two trips into the northern end, covering practically the same region as that traversed by a Geological Survey party in 1901. My first was a hiking and camping trip with Ad Santel (the wrestler), Dr. Dresser, and Albert Jones; the second was with Wes Watson and Era Martin (ranchers living about four miles from the northern edge). The peculiar features seen on those trips led me to take a third across the region in the hope that even more interesting phenomena might be encountered.

EXPLORING AN UNKNOWN REGION IN THE UNITED STATES

One morning in May W. L. Cole and I, both of Boise, Idaho, left Minidoka, packing on our backs bedding, an aluminum cook outfit, a 5 x 7 camera and tripod, binoculars, and supplies, sufficient for two weeks, making a total pack each of 55 pounds.

We also took with us an Airedale terrier for a camp dog. This was a mistake, for after three days' travel his feet were worn raw and bleeding. In some places it was necessary to carry him or sit and wait while he picked his way across.

North of Minidoka, for about 25 miles, we crossed a rolling lava plateau, after which came comparatively later flows of lava. So far as can be learned by diligent inquiry, we were the first white persons to cross this plateau from south to north (see map, page 306).

For three days our travel was over the

TAKING HORSES TO WATER DOWN A CINDER RIDGE

The cinder cones, or buttes, of southern Idaho are extinct volcanoes of recent date, and of remarkably fresh appearance. They are composed, to a great extent, of dust, volcanic sand, and gravel (called lapilli), thin, cakelike forms of lava, volcanic bombs, and rough, ball-like masses, known as scoria. The prevailing colors are red and brown.

uninteresting, broken-up lava surface known as AA flow (a term derived from the Hawaiian natives, who apply it to a similar surface found in their islands). It was the hardest going imaginable, each rock seeming on a balance and ready to turn the instant it was trod upon.

Our water on this part of the trip was snow and ice which we found in crevices.

WATER FLAVORED WITH WRIGGLERS

The fourth day out we sighted an Indian monument in an open flat, and 20 feet from it we found a hole about two feet in diameter, that opened downward like an immense cistern. This was full of clear water. About 10 feet to the west of this was a lava crack, down which we could see some 15 feet before it angled off.

After drinking our fill, we made the discovery that the water was full of innumerable little bright red wrigglers that looked like small shrimp. Each was about three-sixteenths of an inch long. However, the water was good and one cannot afford to be squeamish in desert country.

We located this water hole by compass bearings on Red Top Butte and Sugar Loaf Butte, noted on the map (see page 306). It is the only water in this vicinity which can be depended upon the year round.

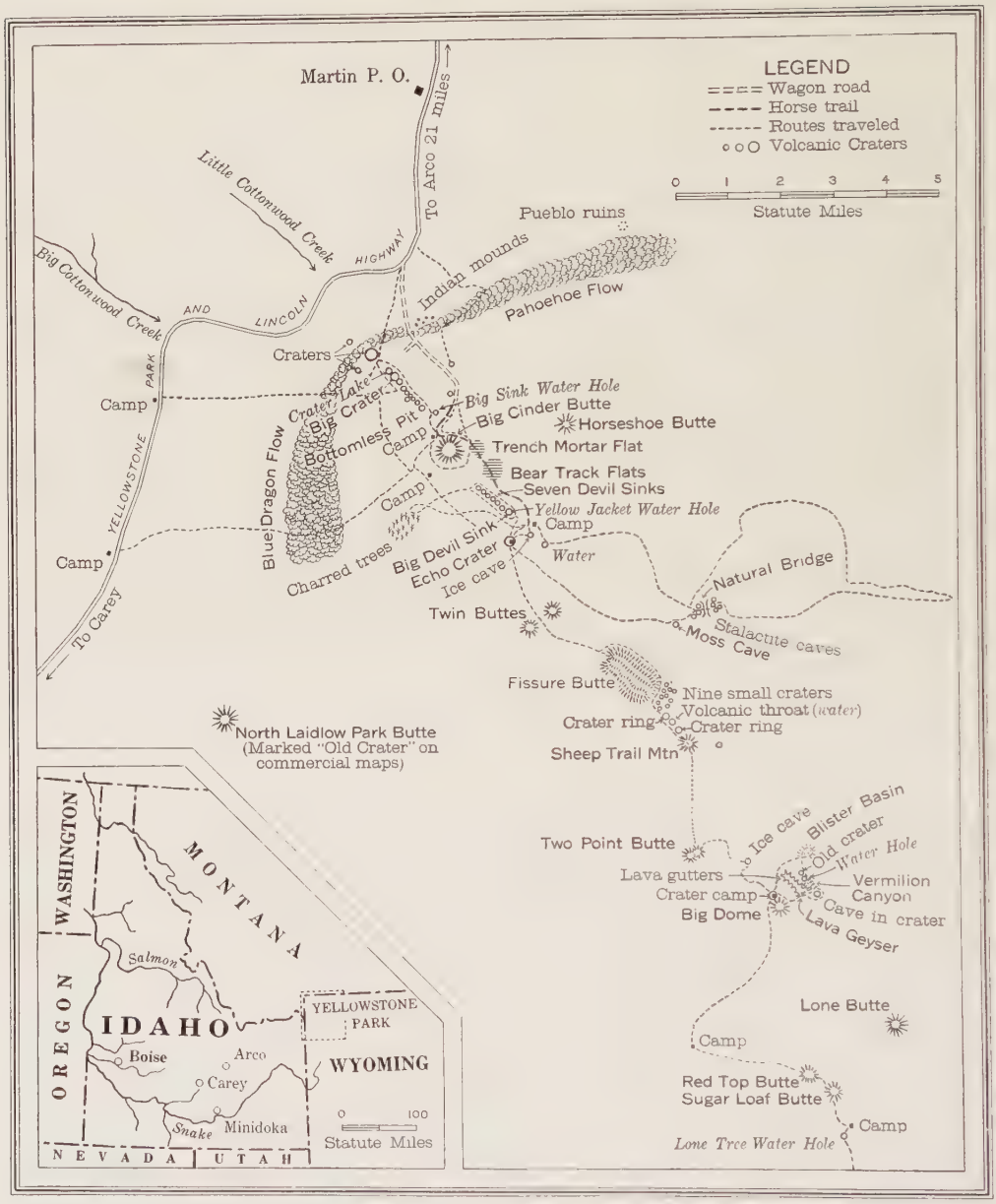
The lower slopes of Sugar Loaf were covered with wild onions, which were crushed as we walked and gave out an odor more pleasant to tell about than to experience.

LOOKING SOUTH FROM A RED-RIMMED CRATER

The vegetation of this region includes, besides sagebrush, a few species of pines and junipers, the pear-leaf cactus, and such flowers as larkspurs, wild violets, and daisies. The later lava flows, however, are barren—not even a blade of grass has been able to take root on some of them.

AROUND THE CAMP FIRE

At night, in the weird reflections of a camp fire, the surrounding sides of this crater appeared like a gigantic funnel with flickering colors of red and black. Its floor acted as a sounding board for the notes of birds migrating northward far overhead.



Drawn by A. H. Bumstead

A MAP OF THE "CRATERS OF THE MOON" IN IDAHO

The dotted lines indicate the routes taken by the author on his several expeditions through this unique volcanic region.

Along the slopes there were evidences that bears had been digging for roots and rolling rocks for ants.

From the top of Sugar Loaf we picked up an old Indian trail which resembled a light streak winding through the lava. When the sun was directly overhead it could be seen to advantage, but at other times was difficult to follow. Think of the years of travel necessary to make that mark on rock!

Some miles to the north was the butte called Big Dome, and a few hundred yards north of it a crater several hundred yards in diameter and about 200 feet deep.

We camped in the bottom of this crater

EXAMINING A SMALL CRATER IN VERMILION CANYON

The lava field of the Snake River plains of Idaho is larger than any other in North America, so far as is known, except that of the Columbia River. One writer, summing up his general impression of the Snake River lava desert, says: "It was as if the great plain had been filled with molten rock which had kept its level and wound in and out along the bays and promontories of the mountain slopes as a sheet of water would have done." The Craters of the Moon district occupies about 300 square miles of the total 27,000 square miles of the Snake River field.

that night, and the experience was well worth the climb up and down. Imagine yourself in some gigantic funnel of bright red and black, weird in its reflections of the camp fire, with the stars above. A peculiar feature of the bottoms of the craters was that they seemed to act as sounding boards for the notes of the birds migrating northward far overhead. Their faint calls were gathered and intensified until the birds seemed only a few feet away. Near here we built a signal fire that was seen by people watching for it 30 miles distant (see page 305).

MAGNETIC CRAGS MAKE COMPASS USELESS

Half a mile east of Big Dome we found an immense crater ring that looked as if the top of a mountain had collapsed and fallen back into the volcanic throat. From the center crags of bright-red lava and burnt cinders jutted up. In some places the lava was black, as if smoked in a fire.

The crags had magnetic properties, and the compass needle could not be depended upon when near them. About a quarter mile to the northwest was a large fissure, which we called Vermilion Canyon. The floor, a hundred or more feet in width, was composed mostly of cinders; the walls of lava were a bright, almost a vermilion, red in the sunlight. Near the center were several extinct lava spouts, one of which was 25 feet in diameter and built up so that it resembled the geyser formations of Yellowstone Park. In the center of it was the throat, about 5 feet wide and 18 feet deep. The sides had fallen in and choked it up.

Fifteen feet south of this was a hollow cone, built up 4 or 5 feet. One side had fallen in, exposing the throat, which went down 25 feet and then angled off, we could not tell how far. Fifty feet to the north was another cone, about 4 feet high and 2½ feet in diameter at the base. This had a 6-inch hole in one side, which

INVESTIGATING A LAVA SPOUT IN VERMILION CANYON

The bird and animal life of this fantastic region includes sparrow hawks, mourning doves, rock conies, rabbits, chipmunks, mice, kangaroo rats, and other species. Rattlesnakes, however, are absent, although they abound on the edges of the flows. It is probable that the snakes were killed off at the time of the eruption, and that they have as yet been unable to cross the immense lava barrier.

opened up as it went down—how deep we could not gauge, as it had drifted full of snow.

Near here we saw a pile of rocks with a piece of charred sagebrush in it pointing to another water hole that probably contains water during the summer. Working our way through the fissure for a quarter of a mile, we found it opened upon a flat, and about 600 yards to the north was another crater similar to the one just passed. As we sat on the east side of its rim, we saw below us a hundred or more large lava blisters or bubbles. In many instances the tops had fallen in, disclosing rooms from 8 to 10 feet across and as high as 6 or 7 feet. The shells of these lava bubbles were from 6 to 8 inches thick. Their color was a grayish brown.

DISTANCES WERE DECEPTIVE

At all places of interest I set up the compass and triangulated on the more prominent buttes shown on the accompanying map (see page 306). Sometimes it was necessary to move the location several hundred feet, as the needle was attracted to the rocky points. In one spot the north end of the needle swung

COMING OUT OF A LAVA SPOUT, VERMILION CANYON

This canyon has a cinder floor over 100 feet in width and lava walls of a vermilion color in the sunlight. Near the center the expedition found extinct lava spouts, one of which resembled the famous geyser formations in Yellowstone Park.

completely around and pointed within 7 degrees of due south.

Estimating distance was also very difficult, owing to the lack of any object of known size to use as a scale. We usually found that distances between specific points were about half again as far in an air line as we estimated.

West of the crater beside Bubble Basin we saw channels winding through the lava flat just as meandering brooks might cross a level meadow. Examination showed these to be lava gutters. Here the plastic lava had flowed down grade, assuming all the shapes of a mountain stream. It was in waves, rolls, twists, and levels.

As we stood on the edge and looked down, we tried to imagine the wonderful sight when the whole lava bed was glowing red.

A CAVE COVERED WITH CRYSTAL ICE

Traveling northwest for a mile, we came to another Indian marker—a pile of rocks. It had a smaller pile at the base and, in a line with it, about 20 feet distant, at the base of a cliff, was the entrance to a cave that opened up into a room 18 feet wide by 12 feet high. From the ceiling hung clusters of immense ice stalactites, sometimes touching a few stalagmites of the same material below. The floor was covered with ice so clear

LOOKING ACROSS ECHO CRATER

This vividly colored crater is 700 feet deep and about one-fourth of a mile wide. The eastern side has breached away until it is only 100 feet high. Viewed from the center, the crater shows the effects of two explosions, the first of which formed the crater, the second blowing a hole in the bottom. A ridge on the southern end is pitted with 14 smaller craters, 9 of which are of the blow-out, or explosive, type. Echo Crater is one of the few in the district having trees on the inside (see text, page 312).

that when I first reached it I dipped down for a drink.

Lighting our single candle, we worked our way for about 50 yards, until the passage narrowed down to about 2 feet in width and 1½ feet in height. After about 10 feet of this, it opened again into a drop-off that blocked our farther progress.

When leaving we restored the old Indian marker, which had partly fallen down.

CRATERS BANDED WITH GREEN AND YELLOW

North of this point we found a high cinder cone whose sides were terraced with old mountain sheep trails. They stood out so prominently from a distance that we called it Sheep Trail Mount. In climbing to its top to triangulate our position, we found it had a double crater, or rather a crater within a crater, evidently caused by two heavy explosions at different times.

The sides of the crater were banded with rings of green and yellow. This was the only sulphur deposit found on the trip.

On the very top of the cone we noticed fresh bear signs, where a grizzly had sat for some time looking at the land below.

About 200 yards to the north was another large crater, 300 yards wide and 150 or 200 feet deep. For three-fourths of its circumference the sides were perpendicular, the balance being a cinder and ash slope.

About 100 yards northwest of the north rim of this crater we found a blow-out cone, with a throat about 10 feet wide and 15 feet long, that went down 30 feet and branched off.

While Mr. Cole was adjusting the straps of his pack, I noticed a narrow crack in the side of the throat and climbed down. The snow had drifted into the passage 15 or 20 feet. The north wall had a sort of lava oven about 10 feet high and hollow, which resembled an inverted wasp nest, the sides being about 8 inches thick.

Fifteen feet north of the oven was the rim of another crater blow-out, 100 feet across and 150 feet deep. Fifty yards from the edge of this were nine small blow-out craters.

Were I gifted with the art of word painting, I might in some small way suggest the wonderful coloring of these craters. Picture yourself standing in some vast amphitheater whose towering walls are a riot of yellow, green, orange, brown, and black, with brick red and vermilion predominating. Imagine, too, an awesome, enveloping silence. I noticed that at places like these we had almost nothing to say. It was little wonder the Indians feared and shunned the region.

After leaving this scene, our trail lay along a series of cinder cones for about seven miles, each with a depression in its top. Examination from a distance with the binoculars showed no unusual features worth the climb, and when one is carrying a pack weighing 55 pounds over this kind of country one does not climb for the mere pleasure of it. As our food supply decreased, we increased our load with oddly formed pieces of lava rock, and the last day found our pack nearly as heavy as when we started.

A PRISONER IN A CRATER

The night we reached the point marked Echo Crater on the map, Cole's feet had become so badly blistered that the pain of walking was almost unendurable. The dog was in terrible shape also; it was pitiful to watch him, as he hobbled after us.

We planned to camp for several days, while I worked out alone. When morning came the tendons in one of Cole's feet had swollen and were so stiff he could not bend it. It was then decided that he should stay in camp and bathe his foot while I tried to reach Era Martin and Wes Watson, who were waiting to come back with us from the north end. That day I made the round trip of 28 miles, getting back at dark. I carried only a gun, camera, and canteen.

It was on this trip that I had rather an odd experience. In passing through a pahoehoe flow (a word also borrowed from the Hawaiians and used to distinguish a smooth, ropy flow from the rough, broken-up, ice-jam formation of the AA flow), I noticed a hole, 15 feet wide and 10 feet deep, evidently caused by the cave-in of the roof of some underground passage.

Happening to look down, I saw a mountain sheep's skeleton with the horns

FILLING CANTEENS AT BIG SINK WATER HOLE

The water supply of this region is hidden in tanks or holes at the bottom of blow-outs, and can be found only by following old Indian trails and mountain sheep paths, or by watching birds as they make sudden drops into these hiding places. The water is usually cold and free from algæ.

in a good state of preservation. Carelessly I laid aside my gun, camera, and canteen and jumped down, alighting on some wind-blown cinders which happened to be at one end. After looking the horns over, I started to climb out, and found that the farthest I could reach lacked about four feet of the top. To be frank, I had some very queer thoughts, chief of which was, Will anybody ever find me or shall I, like the sheep, lie here for years?

Sitting on one of the rocks that littered the floor, I rested and thought. After a time, by rolling and lifting some of these rocks into a pile at one end, I had a mound from which I could easily reach the rim and draw myself up.

Echo Crater, as we called it, is one of the most beautiful in this region. It is 700 feet deep and is one of the few craters having a growth of timber on its sides and bottom. The dark green of the pines and cedars emphasized the vivid coloring common to all these craters. It was an ideal camping place, our camp being in the shade of the west wall after 2.30 p. m.

The acoustic properties of the site were most unusual. One morning, just at daylight, I was awakened by the loud calls of a bird. I lay trying to place it, and finally got up to locate the source, and found a robin singing in one of the pines at the foot of the west wall. We afterward took turns in singing and yodeling from that side to hear the echoes break the voices up and fade away. The east side produced no echo.

AN ICE CAVE OF UNUSUAL BEAUTY

About a quarter of a mile east of Echo Crater is the ice cave discovered on the trip of the year before. Happening to look down in one of the numerous sinks with which this region abounds, I saw a black opening which had the appearance of a cave. Climbing down one side of the pit, which was 100 feet long and 30 feet deep, we were surprised at the rush of cold air from the entrance.

The cause was immediately apparent. It was an ice cave and one of the finest examples, I believe, in existence. The floor was a conglomerate mass of huge

"THE BRIDGE OF TEARS"

This natural bridge of solid lava doubtless covered an underground cavern at one time. It has a 50-foot span, and the height from floor to roof of arch is more than 15 feet. West of this bridge is a cave, where the author discovered fresh bear tracks, but no live animals were seen.

EXAMINING VOLCANIC BOMBS

Most of the lava bombs on Big Cinder Butte resemble footballs, with projections, or "ears," at each end. Some are compact throughout; others have an outer crust, sometimes an inch thick, of black basalt. The shape assumed by the liquid lava before cooling depended upon the length of time it was in the air and on the manner in which it rotated.

A SPATTER CONE ON TRENCH MORTAR FLAT

Many of these blowholes, or fumaroles, have perpendicular throats from four to twenty inches wide, and are twisted or rifled like gun barrels. Most of the hundred or more cones on this flat have been plugged with small stones, probably by Indians.

lava blocks. These and the walls were incrusted with about two inches of ice as clear as glass, through which the structure of the rock could easily be seen.

We struck matches and were surprised to see hanging from the ceiling many ice stalactites, some 4 to 8 inches in diameter at the base and from 3 to 8 feet long. In places, especially where there was a ridge in the ceiling, they were in closely packed clusters. In spots I noticed ice stalagmites building up to meet the stalactites from above.

Forty-five feet from the entrance the tunnel narrowed and inclined downward at an angle of 15 degrees. Breaking off the tips of some of the icicles, I threw them down and could hear them skidding and sliding on the ice for some distance. It was not advisable to venture out on this ice incline, for a slip might have projected us we knew not where.

During the month of August, on a subsequent trip into this region, I visited the cave and found it full of ice on the bottom, but without the icicles or incrus-

tations on the wall. At the south end of the pit we noted another cave, which had about three feet of water over the stratum of ice. This went off into still another cave of unguessed dimensions.

At this point my curiosity was aroused by the number of mourning doves flying about. Knowing their habits, I wondered at their appearance in a region lacking water. I followed their course with the binoculars, just as a bee hunter would line bees to a bee tree, and was surprised to see them drop down into a blow-out. Following them, we came upon a pool of water five feet in diameter.

It was an extremely hot afternoon, in the middle of August, and the heat on the sides of the blow-out was terrific. The rocky slopes burned the hand. We were wet with perspiration as we reached the bottom. Dipping up a cupful of water, we were astonished to find it icy cold—so cold, in fact, that it hurt our teeth, and we put the cup down on the hot rocks to warm. This phenomenon can only be accounted for by the supposition that it was seepage water from an ice cave.

By lining flights of doves, four other water holes were located, all as cold as the first. One was covered with an inch coat of drowned hornets that had been chilled and had fallen in. The water underneath was pure and sweet. We named this Yellow Jacket Water Hole.

On the north rim of the big sink or cave-in containing Yellow Jacket and about 50 feet from the edge are the remains of a perfect lava geyser built up 5 feet, with a spiral hole in the top which forks at a depth of 15 feet.

The sink itself is about 400 yards wide and 150 feet deep. We named it the Big Devil. Just to the north of it is a series of six smaller sinks or blow-outs. We called the row the Seven Devils. One of these also has a water hole.

A VOLCANIC CRATER SHOWING ITS COATING OF LAVA PAINT

The deep-blue film on the surface of some of the lava flows is a "desert varnish," which is due to the evaporation of water drawn from within the lava. This process has brought about a chemical precipitation of some of the material leached out of the lava.

LOST IN A FOG

The morning after we had explored this section there was a fog so thick that a person could see but 150 feet in any

THE INTERIOR OF AMPHITHEATER CAVE

This is one of a series of eight caves found near the Bridge of Tears. It is an almost perfect model of a miniature theater, with a circular, sloping auditorium, a miniature bridge of lava for the stage, an orchestra pit, back drop, and domed ceiling. It is lighted by a 6-inch hole in the roof. The coloring of this group of caves is red, brown, and black, with splotches of white.

direction. We started out hoping that it would lift, but after an hour of aimless travel we decided to go back to camp.

Watson happened to be in the lead and we naturally followed him. I finally asked him where he was going, and when he said "camp," Cole and I undertook to show him where he was wrong. The fog by this time was so dense that 75 feet was about as far as we could see. The sun was invisible.

Watson in turn laughed at us. We referred to our compass, and the needle pointed in the direction we thought south. I suspected this to be another case of magnetic attraction, so tried a different direction finder.

No matter how dull the day, if you lay your knife-blade on edge on the back of your watch or on a piece of paper, there will be a faint shadow; turn slowly around until you lose the shadow, and in

FOLDED FORMATIONS OF THE PAHOEHOE FLOW

This lava formation is about 20 miles wide, and consists of ridges, folds, crevices, and cracks. Some of the shapes resemble crumbled blankets, knots, and ship's hawsers neatly piled. *Pahoehoe* a Hawaiian term for a smooth, ropy, lava flow (see page 311), means "having a satinlike finish." * Indians had marked the trail across this flow by laying rocks on pieces of sagebrush pointing to caves or water holes. Occasionally old trails, marked by gray streaks across the bare rock, worn by ages of travel, can still be followed for short distances.

that direction is the sun; point the hour hand of your watch there, and half way between that point and the mark 12, for the noon hour, is due south, or near enough for practical purposes. This checked our compass; we had to admit we were wrong. It was the first time in my life that I had been lost.

Watson now got his bearings from some rocks he had passed.

About a half mile northwest of the northern end of the Seven Devils we came upon a large cinder flat a mile long and a half mile wide. Here we encountered another strange feature of this land. In general, these flats were barren and packed so hard that an automobile might have been driven across at any place, but at this point we noticed a series of light-brown dots extending in lines crisscrossing the flats.

When we came to them we were surprised to find old bear tracks, into which the wind had carried a species of plant seed that had taken root and exactly filled

* See "The Hawaiian Islands," by Gilbert Grosvenor, in the NATIONAL GEOGRAPHIC MAGAZINE for February, 1924.

BIG CINDER BUTTE AND THE PAHOEHOE FLOW

This volcanic cone of reddish and black lapilli, the highest in this region, rises 600 feet from the plain, but was twice as large before its top and southwest side were blown off. Its slopes are covered with large pancakes of lava and with curious globular formations which resulted from the whirling motion of the lava as it was thrown high into the air. They range in size from a finger's length to 12 feet and are termed "volcanic bombs" (see illustration, page 313). The north and east sides of this butte are timbered with pines and quaking aspens.

the tracks. It was a small grayish-colored plant about one and a half inches high—hardly enough in some cases to show above the level of the tracks. Specimens I brought back have been identified as *Eriogonum acaule,* a pigmy variety of the buckwheat family.

Think of tracking a grizzly bear that had crossed here possibly hundreds of years before! In a few places wild rye grass had taken root and was crowding the smaller plant out.

We called this place Bear Track Flat.

Adjoining Bear Track Flat on the north was a similar one having features all its own, which consisted of more than 100 blowholes or fumaroles. These had at some time spewed out lava through from 4- to 20-inch throats. In many instances they looked like old tree stumps, 3 to 7 feet high. All had holes in the top and these openings were spiraled or twisted like the riflings in a gun barrel. We saw one with two openings about 5 inches apart and 4 inches in diameter. Another was found that had forked about half way from its base. These branches had broken off and lay on the cinders, in appearance like pieces of twisted spiral pipe.

All the openings except three were plugged with bits of rock dropped in probably by Indians, as the old trail passed along the cinder flat 100 yards distant. Several were examined in which the opening angled off at a 45-degree slope and to unknown depths. They reminded us of a number of trench mortars, so we gave this the name of Trench Mortar Flat.

STRANGE FORMS OF THE LAVA FLOW

From our camp in Echo Crater we made an excursion for 9 miles out into a lava flow some 20 miles wide extending to the east. Most of the flow has a pahoehoe surface (see text, page 311). In places there are ridge after ridge and fold upon fold, with crevasses and cracks;

EXAMINING PROBABLE SIGNS OF THE LATEST ERUPTION

The sagebrush is charred and the lava pancakes are half an inch thick, with a high gloss on the upper surface. It is possible that the most recent lava flow in this region took place only 150 years ago. Six large streams flowed from the Cinder Buttes district at a late date, and three of them are as fresh as if they had congealed and come to rest but yesterday. The lava looks black, as one walks over it, but at a short distance and in certain lights it has a light-gray appearance, as if covered with dust. This surface "bloom" indicates youth and is absent from flows known to be older.

again, there are huge folds and waves, as if some one had crumpled a heavy blanket.

One place suggested a number of great ships' hawsers neatly piled; another had a long, sinewy twist of lava tied in as neat a knot as any sailor could make. How the ends could have twisted around and come through the loop is a mystery. I found a small specimen of this kind and carried it out with me. One flow had spread until it looked like an automobile speedway, except that it was broken by narrow cracks caused by cooling.

One day we crossed a stretch that tinkled with a hollow sound. Happening to notice that the surface was cracked and loosened in large sheets, we turned several pieces over and found the bottoms covered with jagged masses of nail-like projections all pointing in the direction of the flow. Many of the points were needle-sharp.

In one place the plastic lava had taken a circular, flowing motion while hardening, just as if it had been a large whirlpool several hundred yards across. Watson built a row of monuments from this lava formation back to the caves, described further on.

About four miles from Echo Crater we came to a large black hole. Climbing down, we entered a lava stalactite cave, each stalactite from 2 to 7 inches long and covered with green moss. We went in about 75 feet.

A short distance from this we reached a second moss cave, extending to the east. Farther on we found another cave, where, in the dust around the entrance, we discovered fresh bear tracks. As we started in, I asked Cole if there were any word he wanted sent to his folks. What he answered is not printable. About 20 feet in, the cave forked, one branch going west and the other northwest. We entered each of these about 100 feet, until they narrowed down, making it necessary to crawl.

BOTTOMLESS PIT WHEN VIEWED THROUGH A MIST

Northwest of Big Cinder Butte the expedition found a row of seven lava sputter cones, one of which went down 40 feet and then opened up like an hourglass. Large rocks when rolled into it were never heard to strike bottom (see text, page 327).

THE STARTING POINT OF THE BLUE DRAGON LAVA FLOW

Perhaps the strangest features of this flow are its color and texture. Its tint is a deep cobalt blue, with a glossy finish, resembling varnish or enamel. The coating averages one-fourth of an inch in thickness. The play of light and shadow at sunset turns this formation into a twisted, wavy sea of grays, purples, blues, and blacks (see also illustration, page 322).

THE BLUE DRAGON LAVA FLOW

This remarkable flow is well named. Its surface is netted and veined with small cracks like scales of a prehistoric monster, while ropy twists of blue and gray lava, bursting through an older flow, have spread out in branches resembling the claws and legs of a dragon. This fantastic region of folds 30 feet wide, of whirlpools, gigantic snakes, and frozen waves, extends 11 miles to the southwest of Tycho Crater (see map, page 306, and text, page 327).

About 100 yards from the entrance to this cave, at the base of a cliff facing south, Watson discovered the entrance to a cave leading northwest. It also contained bear tracks.

East of the bear caves we came upon a natural bridge of lava arching a point where two cliffs of lava narrowed down. It had a 50-foot span, and from the floor to the roof of the arch was 15 or 18 feet. Its width was 75 feet. There was a pine tree growing under the east entrance. One of the party bumped his head on the roof near the edge, so we laughingly called this the Bridge of Tears (see illustration, page 313).

A CAVE FORMED LIKE A MODERN THEATER

East of the Bridge of Tears we came to the entrance of what we afterwards decided to call Amphitheater Cave. Climbing down, we found ourselves on the east side of a room some 40 feet wide and 60 feet long, with a domed ceiling 20 feet high.

As we sat on the north side, we beheld to the south a perfect stage. The floor was double, the lower section being about 8 feet lower than the top of the floor above, which was 15 feet wide. It was almost an exact model of a modern theater. To the right of the stage a large rock jutted up; imagination might call it one of the wings.

At the top of the dome the roof had caved in, leaving a circular skylight 6 inches in diameter. Back of the stage and starting on a level with the lower floor, the tunnel led away to the southeast.

We walked and crawled between a quarter and a half mile; but judging distance when part of the way must be made on all-fours and by candle light is difficult. Finally, the passage closed down until the roof was only 1½ to 3 feet high. Leaving Watson and Cole here, Martin and I crawled on about 200 yards, until we came to a place we christened Fat Man's Misery. Martin weighs about 125

"PUEBLO RUINS" OF VOLCANIC TUFA

These peculiar masses were formed when molten lava undermined the sides of a crater, large pieces of which broke off and fell on top of the flow. The fragments are usually black or various shades of red, and when viewed from a distance resemble pueblo ruins of the Southwest. They are from 10 to 80 feet in height and of many curious shapes.

pounds and made it easily; I made it, too, but in all pictures taken after that I faced the camera!

About 50 feet farther on, the passage opened up again, and then closed down, owing to a cave-in of the roof. We could see through, but could go no farther.

The roof throughout was covered with stalactites and the floor with jagged drippings from above. Crawling was a painful operation.

The coloring in these caves was red, brown, and black, with splashes of white.

While proceeding east, Martin and I happened to leave the others to climb to a low mound in the flow. From this vantage point we sighted a lake a half mile long and, to the south of it, what appeared to be a grove of willows and cottonwoods. Turning the binoculars on the scene heightened the effect, and we decided to walk to another elevation, a mile and a half farther along, where we could look down into the basin. When we got there we sat for a few moments examining it, still apparently three miles off,

DEAD AND BURNED TREES WEST OF THE BUTTES (SEE TEXT, PAGE 328)

There is no positive evidence as yet to prove that the dead trees found on the borders of the lava flows in certain instances were killed by heat.

"THE BRIDGE OF THE MOON"

This gigantic stone arch has a span of 125 feet and a height of from 80 to 110 feet. Its golden-brown color contrasts sharply with the dark green of the pines below. As one looks through the arch from point to point in the landscape, the view changes from canyon walls and rocks to a series of green, yellow, and brown rolling hills, set off here and there, in the purple haze of the skyline, by the higher volcanic cones of Moon Valley.

ARCO TOWNSMEN WELCOMING THE EXPEDITION'S RETURN

The peculiar scenic beauties of the "Craters of the Moon" are unique in the United States. In due time this wonder-region will doubtless be opened up to tourists by a road which could be built from the northern end along its eastern side, following the open places that run back through the lava flows in narrow strips.

when suddenly lake, trees, and all floated away and disappeared in the distance. We had been the victims of a mirage.

AN AWESOME PANORAMA

A short distance northwest of Trench Mortar Flat lies the highest of the cinder cones in this region. As it stands today, it is about half its size before the explosion blew off its top and southwest side. The ascent to this point, known as Big Cinder Butte, was through a conglomerate of lava bombs and pancakes, where still plastic lava had fallen and flattened out. Near the top the cinders are broken by a number of jagged crags of red lava; the north and east sides of the butte are timbered with pines and quaking aspens.

From the summit we looked south over the country we had traversed, tracing our course through the maze of lava and cinder cones. On all sides were crater rings, showing we had examined but few of the many. We took turns in focusing the binoculars on the different features spread below. Very little was said except when one of us wished to call attention to something he did not want the others to overlook. We yielded to the influence of silence. Below us we counted six distinct lava flows, each comparatively fresh.

LOOKING DOWN INTO "BOTTOMLESS PIT"

To the north were many sputter cones and the shadowy outlines of craters deeper and larger than any we had passed. A route to some of these was planned, so as to avoid a large part of the rough, broken-up flow lying between.

Two miles northwest of Big

Cinder Butte we came to a row of seven lava sputter cones caused by molten lava which had been thrown out of a vent, piling up to a height of 60 feet. The southern one was the first climbed. Imagine finding a hole 15 feet in diameter and bottomless, so far as we could judge. It went down for 40 feet; then narrowed slightly, after which it opened up, giving the crater the shape of an hourglass. Large rocks rolled in were never heard to strike bottom. We called it the Bottomless Pit.

Near by a volcanic throat about 30 feet in diameter and 60 feet deep was found, full of snow and ice. From the sides hung large clots of lava. The outside slopes were covered with numerous volcanic bombs resembling double-ended pears. In many the ends had curved upward as they had fallen, giving the appearance of buffalo horns. A short way from this was the entrance to the narrow tunnel of another cave.

In this vicinity there were seven lava cones in a row, three of them in a state of perfect preservation. In climbing a high ridge to the north, in order to get a photograph, I descried three of the largest craters in the belt, one of which was a quarter of a mile across and several hundred feet deep. Its northern and eastern sides were perpendicular cliffs of a bright red lava, the balance being a steep cinder slope. The rim was almost a perfect circle.

On my first trip to this place, Albert Jones volunteered to climb to the bottom, to serve as a scale. To my surprise, he was invisible on the ground glass of the camera and could be found in the finished print only with the aid of a magnifying glass. In pictures of a place like this, the camera does not lie, but it does not tell all of the truth, for in its results the colors and gigantic scale of things are missing.

The north rim of this crater is a knife-edge, the other slope being the side of another crater, almost as wide and deep, formed by two explosions, which caused a double depression in the bottom. One contains a small lake. In the spring of 1919 it was about 100 feet in diameter; the following year it had shrunk to 40 feet. We called it Crater Lake and the crater, Tycho, after the large crater on the moon.

As we climbed around the crater walls we amused ourselves by rolling rocks down, watching them bounce and bound, sometimes 100 feet in the air. As they reached the talus slopes below, they reminded us of rabbits on the run, and I could not resist shooting at them. Once we united our strength and pushed a huge rock over the cliff, watching it fall until it reached the slope below, where it rolled, gradually getting smaller and leaving a cloud of dust in its wake.

A LAVA FLOW OF COBALT BLUE

Stretching to the southwest for a distance of about 11 miles, we saw perhaps one of the most remarkable lava flows in the world. Its color is a deep cobalt blue, with generally a high gloss, as if the flow had been given a coat of blue varnish. The surface is netted and veined with small cracks, having the appearance of the scales of some prehistoric reptile. Mr. Israel C. Russell, at one time of the United States Geological Survey, called it the Blue Dragon Flow. It merits the name, as in many places it has burst through the crevasse of an older flow, and the ropy twists of blue lava, spreading out in branches, together with its scaled surface, need but a little stretch of imagination to suggest the claws and legs of a dragon.

It is the play of light at sunset across this lava that charms the spectator. It becomes a twisted, wavy sea. In the moonlight its glazed surface has a silvery sheen. With changing conditions of light and air, it varies also, even while one stands and watches. It is a place of color and silence, the latter broken only by the wail of the coyote and chirp of the rock cony.

About a mile to the north of Crater Lake is an immense cinder cone, the west side of which has breached away, leaving the floor of the crater exactly as it must have appeared when the eruption of lava ceased. Here are bubbles, rolls, folds, and twists, as if a giant's frying pan of thick gravy furiously boiling had been frozen instantaneously.

We sat on the southern edge of the rim for perhaps half an hour before we climbed down. This flow had broken out and traveled northwest for several hundred yards, and then, having been dammed up, had broken through a low

place in the cinder ridge and gone east. Here the channel was about 300 yards wide, and the flowing lava had assumed strange shapes and twists, as if a rapid in a mountain stream had suddenly congealed.

When the eruption occurred the molten lava undermined the volcanic sides, which fell in and floated off on top of the flow, like sticks and sawdust on the surface of running water.

Around the bases of the larger floating pieces of volcanic tufa there are depressions in the lava where the masses had pressed down, as occurs when a greased stick is floated in water. Some of these moats are from 4 to 10 feet deep and 10 to 30 feet across.

TEAPOTS, CHIMNEYS, AND SILOS MOLDED BY LAVA

A mile and a half out on the flow we saw hundreds of these crater-wall fragments, some as high as 80 feet. Viewed from a distance, they resemble the pueblo ruins of southwestern United States. One was about 60 feet high and not more than 20 feet in diameter at its base. From a distance it resembled a silo. How it remained upright as it drifted along is a mystery. Many more were observed that resembled chimneys 10 to 20 feet high, and one was an almost perfect teapot in shape.

About two miles southwest of Big Cinder Butte is a flow with similar formations. Along the north side of the Ruined Pueblo flow are 14 mounds composed of rock and sagebrush, which the Indians have built. They are from 4 to 10 feet long and about 4 feet wide. We had no means of digging into them.

Three well-worn Indian trails come into this belt from the north. The plainest is one that goes in about six miles west of Martin, near the sinks of a lost stream known as Little Cottonwood. It is distinct for about 11 miles, and then fades; yet we found traces of it all the way across. It is sparingly marked with small rock piles and pieces of sagebrush, with rocks to weight them. A few flint or obsidian arrow-points can be picked up along it. Where these trails go and why, no one knows.

Northward, a mile from the Ruined Pueblo flow, are a few more low cinder cones similar to those we had passed. Puzzling features along the west side of this volcanic belt are the many dead charred trees growing in a cinder flat absolutely barren of vegetation of any kind which could carry fire from one to the other. I found charred sagebrush around a lava blowhole near the Seven Devils. A piece of brush was picked up near this spot that had a clot of lava "frozen" around it.

In appearance the flows seem as if they had happened only yesterday, but in reality the latest probably occurred about 150 or possibly 200 years ago. Perhaps the eruptions of spattered lava around some of the small sputter cones occurred about the time of the eruption of Buffalo Hump, in Idaho County, Idaho, in 1866.

The total area of the six young lava flows of this region is about 300 square miles, while that extending above and below this point, along the Snake River plains, reaches the astounding total of approximately 27,000 square miles.

A report has been prepared by Mr. H. T. Stearns, of the U. S. Geological Survey, suggesting to the National Park Service that an area of 39 square miles be set aside as the "Craters of the Moon National Monument." In this area there occurred a fissure eruption displaying surface phenomena which are paralleled only by those in Iceland.

Notice of change of address of your GEOGRAPHIC MAGAZINE *should be received in the office of the National Geographic Society by the first of the month to affect the following month's issue. For instance, if you desire the address changed for your May number, the Society should be notified of your new address not later than April first.*

AUSTRALIA'S WILD WONDERLAND

By M. P. Greenwood Adams

With Illustrations from Photographs by William Jackson, Nor' West Scientific Expedition of Western Australia

ELEVEN million dollars' worth of mother-of-pearl shell and three million dollars' worth of pearls were won, in a period of ten years, from the waters of the Indian Ocean which lap the shores of Western Australia.

Pearl fishers, with their Asiatic crews and divers, scour the coast for 1,100 miles, from Sharks Bay to the north of King Sound. Their activities date back to the early fifties.

Western Australia produces more than three-fourths of the world's pearl shell, and the principal center of this valuable industry is Broome, a straggling township of some 4,000 Asiatics and a few hundred whites, each group occupying its own section of the town.

The Asiatics are employed in the pearl fishing under a special clause in the White Australia Act, which otherwise excludes the entrance of all colored peoples into the Commonwealth.

Fifty-odd years ago there was not a single European settlement in this vast section of Australia, and even now the census returns give a population of less than 7,000 souls, exclusive of aborigines.

From 1628 the northwest coast was visited by many bold mariners, including De Witt and William Dampier, but it was not until 1837 that the first definite attempt at exploration was undertaken by Captain George Grey—an attempt that was only partly successful. The first pastoral settlement in the Roebuck Bay district was established in 1863, and in 1879 Alexander Forrest made his memorable trip, via Beagle Bay and King Sound, to the Fitzroy and Margaret Rivers.

In 1882 Sir John Forrest, of Bunbury, the noted Australian explorer and statesman, made an investigation in this division, and shortly afterward Hall and Slattery discovered the first payable gold in the country at Hall's Creek. Then definite settlement of this great tract of country really began.

It was at Broome, with its glaring sun heat, that the Nor' West Scientific and Exploration Company of Perth, Western Australia, chartered the little 22-ton schooner *Culwulla* and secured the services of Captain Johnson as navigator for the purpose of making a comprehensive investigation of the northwest coast from Broome to Wyndham, the small township at the head of the Cambridge Gulf—a trip made possible through the enthusiasm and financial aid lent by Mr. A. E. Cockram, a citizen of Perth (see map, p. 332).

Under the leadership of Mr. E. J. Stuart, of Perth, and with William Jackson, photographer, the little party of explorers sailed at daylight one morning in May, on a voyage that supplied as many thrills as the most ardent adventurer could hope to encounter in these enlightened times.

A run of 90 miles along the coast brought the party to Ledge Point, where a visit was made to Beagle Bay Mission Station, established 30 years ago by a Spanish religious order. There are 250 blacks permanently at the station, while tribes from the outlying districts make it occasional visits. This mission controls 10,000 acres of land, has several thousand cattle and hundreds of goats and pigs. Coconut and date palms flourish and water is obtained by sinking deep wells. Artesian bores are very common in Australia, many of them tapping water thousands of feet below the surface.

The station consists of 60 buildings scattered over 30 acres, well irrigated with bore water.

WHERE WATERS RECEDE SEVEN MILES AT LOW TIDE

North of Beagle Bay is Chilli Creek, where there is a 28-foot tide. At the ebb the waters recede nearly seven miles.

Under the mangrove trees which fringe the coast there are millions of crabs. Some are bright blue, others scarlet—all about the size of a 50-cent piece—while

THE "CULWULLA," THE NOR' WEST SCIENTIFIC EXPEDITION SCHOONER

larger crabs, three inches long and of a yellow color, simply swarm over the sand. The yellow crabs form into battalions, as if directed by officers, and will show fight when hard pushed (see page 340).

The fisheries wealth of this coast is remarkable, every inlet and river teeming with valuable edible fish. At Broome, a system of catching fish by means of traps is in vogue. The traps are made of wire netting, with wings which form a race. The tide does the work. The traps are covered at high tide, and when the water rushes out, fish are swept into the wire, being caught by the ton.

At Tyra Island, which is reached through wild and swirling tides, M. d'Antoine, a Frenchman, has lived among the blacks for more than 30 years. He owns a lugger, lives in a bark hut, and has a retinue of some 50 blacks—men, women, and children. As a typical beachcomber, he is far from being the picturesque figure that many writers about tropical lands and isles describe.

At the entrance to King Sound, there is a group of islands known as the Buccaneer Archipelago. On Sunday Island, one of this group, Sydney Hadley has a mission station, where he utilizes the black *gins* (women) for collecting the trochus shell, which he ships away. It is from the trochus shell that so-called pearl buttons are made — an industry carried on in France and Japan.

North from the Sound lies the "Graveyard," the *bête noire* of the skippers of the coast, where tiny islands and dangerous reefs are sprinkled all over the sea. Captain Johnson took the *Culwulla* through the Graveyard and passed safely to the more tricky Whirlpool Pass, where the little craft made three complete turns in the comparatively narrow channel, a little more than four miles in length.

At times this pass is quite unnavigable. Its banks are more than 400 feet high in places, very rocky, and run sheer down. The rise and fall of tide here is 35 feet.

HUNTING THE DUGONG OR SEA COW

At Dugong Bay, an inlet in Collier Bay, several splendid specimens of the sea cow or dugong were captured (see page 343).

The hunting of the dugong was carried on by four enormous blacks who, with

A PEARLING FLEET RETURNING TO BROOME

THE ASIATIC CEMETERY IN BROOME

Broome is the center of fisheries which produce about three-fourths of the world's output of mother-of-pearl shell. The death rate among the Japanese and Malay divers is very high, and during the busy season at Broome it is not unusual for a burial to take place almost every day.

Drawn by Charles E. Riddiford

A MAP OF THE NORTHWEST COAST OF AUSTRALIA

the permission of Mr. Hadley, joined the party at Sunday Island. They proved a great asset as good workers and as interpreters when the party met strange blacks. At times, however, the Sunday Islanders were foiled, as the aborigines in different localities speak different dialects. Blacks from down south cannot make themselves understood when they encounter tribes on the northern coast and on the islands.

The dugong is caught like the whale, but, owing to the great thickness of its hide, many spears are turned and broken; so the hunting is not always carried out with success. This mammal is believed by some to have suggested the idea of the mermaid, because it holds its young to its breast and suckles it. The flesh has a flavor akin to both beef and pork, and it is eaten by whites and blacks alike. The meat is used like bacon, fine leather is made from the hide, and the oil obtained from the animal possesses valuable medicinal qualities, having extraordinary powers of penetration.

The dugong industry is being rapidly developed in the State of Queensland and is proving a most important asset. In the North West the blacks hunt these sea cows on a rough raft constructed of mangrove saplings pinned together with hardwood pegs.

The Sunday Islanders speared a splendid specimen that measured fully 12 feet

TWENTY SQUARE MILES OF CORAL

ANOTHER VIEW OF THE CORAL REEF OFF MONTGOMERY ISLAND

The coral reefs of northwestern Australia are magnificent in formation and beauty of coloring. In order to obtain this picture, the Nor' West Scientific Expedition chopped and blasted a channel which allowed the water to drain from one of the picturesque lagoons left by the tide on the top of a great section of coral. When the water in the lagoon fell about seven feet, a dingy was placed on the lagoon, and in this craft the photographer secured the pictures. The coral is built up by that industrious little marine creature which is responsible for innumerable atolls and small islands in the great South Seas and Indian Ocean.

THE RULER OF TYRA ISLAND IN HIS BARK HUT

THE TYRA ISLAND POPULATION

M. d'Antoine, known as "Frenchie," has lived among the blacks for 40 years and is an extraordinary man—a typical beachcomber. He owns a small lugger, which enables him to touch civilization once in a while to dispose of his beachcombings, mother-of-pearl shells, trochus shells, etc., and to secure supplies (see text, page 330).

MONTGOMERY ISLANDERS EXPERIENCE AN UPSET IN THEIR DUGOUT

"GINS" (BLACK WOMEN) GATHERING TROCHUS SHELL ON SUNDAY ISLAND

The largest and handsomest of the trochi, or top shells, are found in the Indian Ocean and Australian waters. All are pearly inside. One of the small opalescent varieties is gathered in quantities to be strung into necklaces. From another variety bracelets are cut from cross-sections, five or six being worn on one arm.

THE "CULWULLA" AND THE BEAGLE BAY MISSION SCHOONER IN CHILLI CREEK

THE "CULWULLA" AT OYSTER BAY, A SMALL INLET ON THE NORTHWEST COAST

FLEDGLINGS IN A SEA HAWK'S NEST

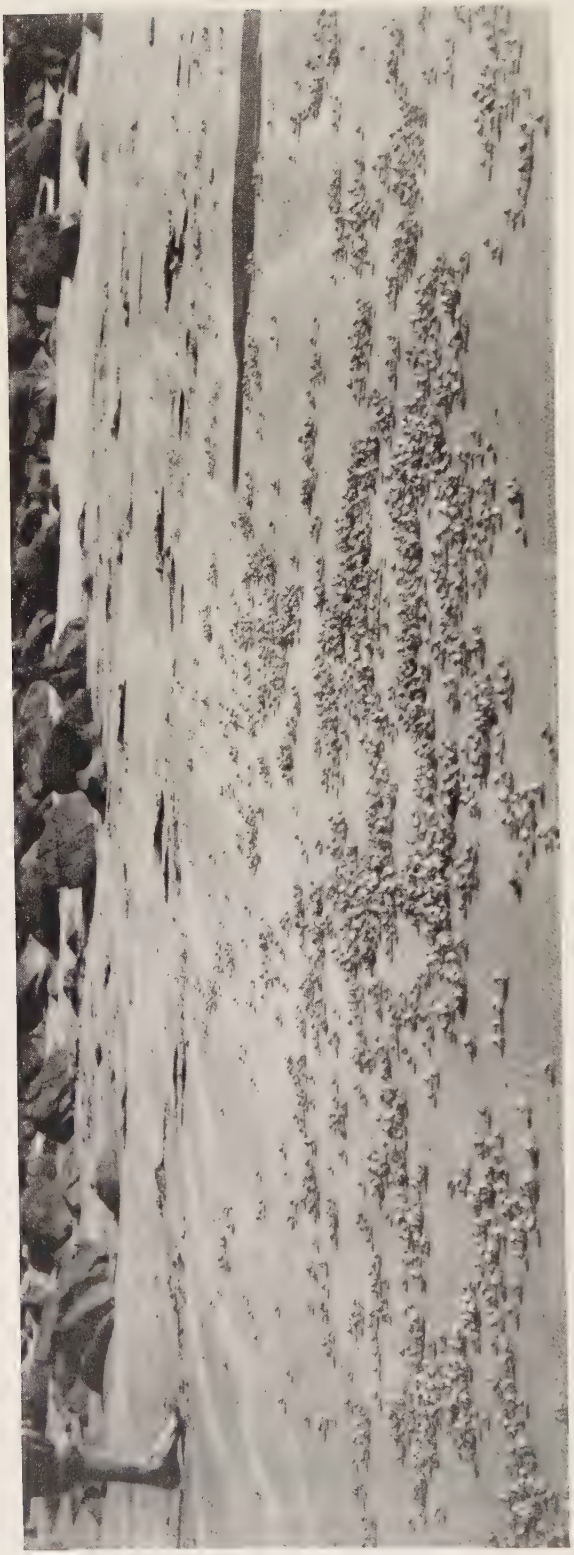
These large nests, composed entirely of sticks and bark, are to be seen on many of the headlands of the wild northwest coast of Western Australia (see also illustration on the opposite page).

SOLDIER CRABS: THEY USUALLY GATHER IN MASS FORMATION AND WILL ATTACK IF HARD PRESSED (SEE TEXT, PAGES 329 AND 330)

AN AUSTRALIAN ABORIGINAL WITH SEA HAWK'S EGGS

This black boy, whose splendid physique has surprised all those who are familiar with the build of the Australian aborigines, climbed this cliff with utmost ease and robbed the great beaconlike nest.

FORREST RIVER ABORIGINES WITH THEIR THROWING STICKS, OR WOMERAHS (SEE TEXT, PAGE 356)



CRABS AT CHILLI CREEK. MILLIONS OF THESE TINY CREATURES, THE SIZE OF A 50-CENT PIECE, SWARM ALONG THE BEACHES

in length and weighed nearly 600 pounds.

Butcher Inlet provides another remarkable illustration of the power of the tides on the northwest coast, as fifty miles inland the rise and fall is 18 feet, while at the entrance the fluctuation is 30 feet.

A terrific conflict takes place at the turn of tide, when the outgoing waters meet the incoming sea, the effect being to swing a craft at anchor in the inlet backward and forward like the pendulum of a clock. It is near here that the Charnley River pours out its waters.

NAVIGATING A CROCODILE-INFESTED RIVER

A run up this stream provides plenty of excitement, as here and there great mud-covered alligators, with which the waters swarm, slide down the banks. The black boys, with Stuart in the motorboat, took care to stick close to the craft, as these reptiles rose near the boat, seeming to resent its passage.

The country is timbered and ranges of hills nearly enclose the river.

At almost any point on the coast, dugong can be speared, while a sailfish—a species of fish with a large sail-like fin, which is raised when its owner is on the surface of the water—was captured by E. J. Stuart. It was beautifully colored and measured 8 feet in length, its sail covering an area of six square feet when fully extended.

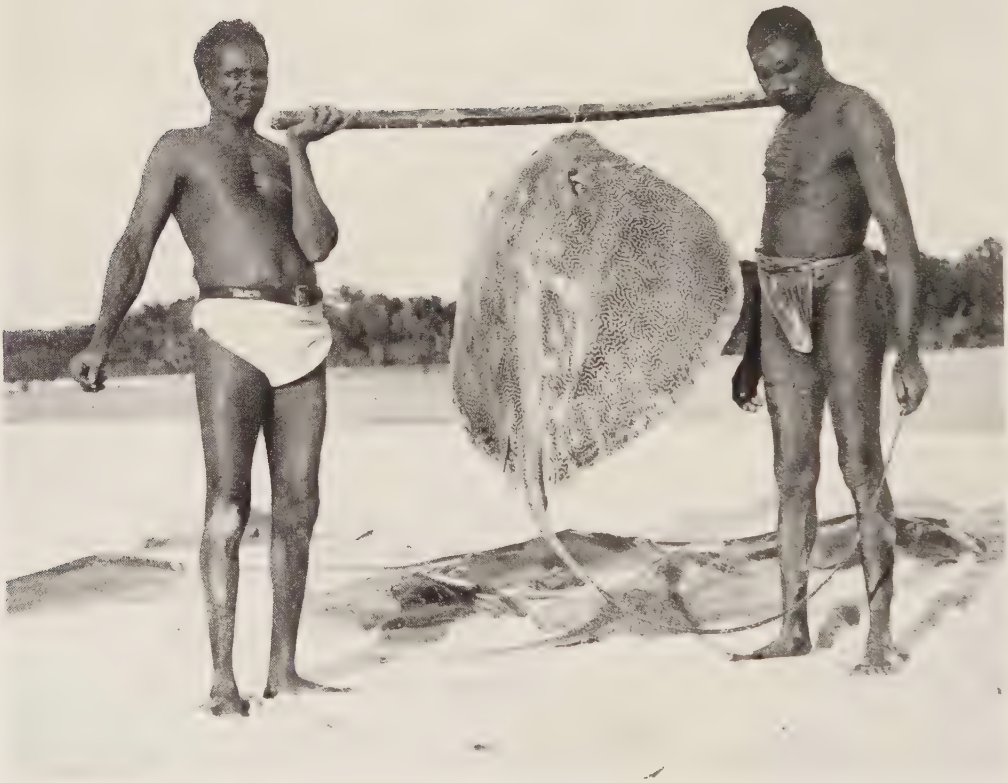
Another strange creature is the sucker fish, or shark sucker, which clings to larger fish and to hulls of vessels by means of ridges or "vacuum cups" at the back of its head, solely for the purpose of "stealing a ride"—a veritable hobo of the sea.

PHOTOGRAPHIC RECORDS OF CORAL FORMATIONS OBTAINED

Montgomery Island is one of several small bits of land dotted

SEVEN STINGRAYS SPEARED BY SUNDAY ISLANDERS AT NAPIER BROOME BAY

A sting from one of these rays has been known to cause death. Quite recently a fisherman near Sydney was stung by one about the size of a dinner plate and a finger had to be amputated.



TWO NATIVE MEMBERS OF THE NOR' WEST SCIENTIFIC EXPEDITION DISPLAYING A 400-POUND STINGRAY

These giant blacks, both standing close on 7 feet, speared the monster in the shallow waters of the northwest coast of Australia. The poisonous stinger, which is actually an extension of the spine, projects about two feet down from the thick part of the tail, and this is used as a means of offense and defense. Stingrays up to 600 pounds have been caught on this coast.

among the dangerous coral reefs which strew the coast for miles north of Butcher Inlet. One reef has an area of 20 square miles and is completely covered at high tide, but when the turn comes the sea rushes from the reef like a waterfall, eventually leaving it high and dry.

EACH BLACK CARRIES HIS "VISITING CARD" ON HIS BODY

Stuart got all hands to cut and blast a channel through this reef, allowing the water in one of the lagoons to drain away. This enabled Jackson to photograph the sides of the lagoon from the dingy, which was carried over the reef and placed on the water left in the miniature lake. He obtained an excellent record of coral formations (see page 333).

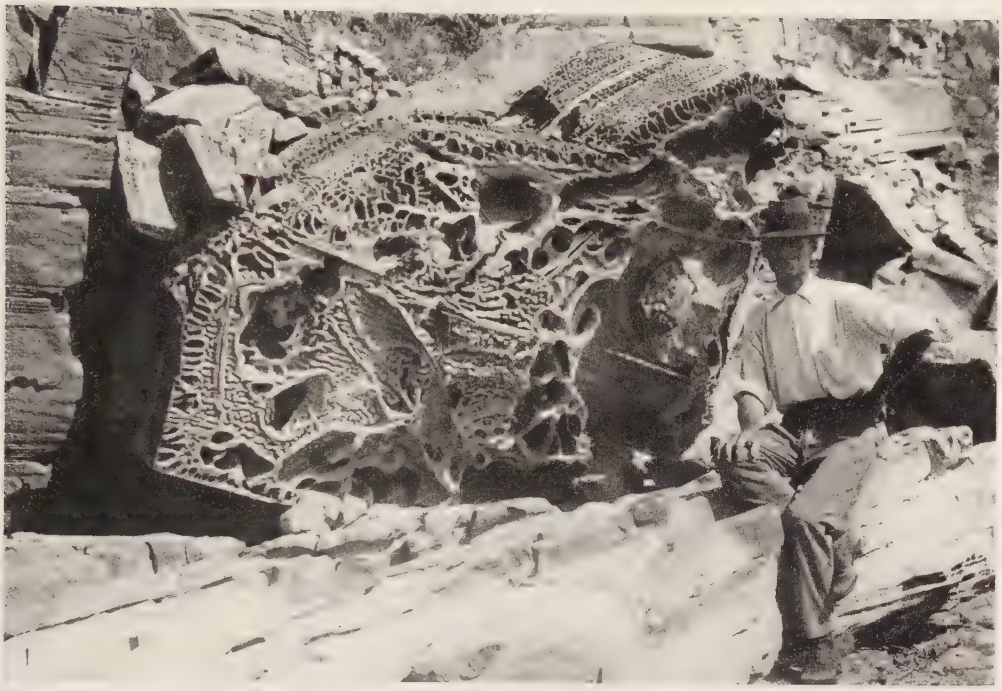
On the adjacent Montgomery Island the blacks are noted for the remarkable way they ornament their bodies by means of cicatrices. Their markings are said to be the most unusual in Australia. The skin is cut with a sharp shell, and mud, obtained from around the roots of the mangrove scrub which grows in the salt water, is then rubbed repeatedly into the wound. Tribal marks are made thus, and each man carries his visiting card on his

A GIANT DUGONG; LENGTH, 12 FEET; WEIGHT, ABOUT 600 POUNDS

The flesh of the dugong is eaten by whites and blacks alike. It is a mammal and is hunted like the whale. The dugong holds its young to its breast and suckles it; hence the tradition that it is the original "mermaid."

DUGONGS, OR SEA COWS, CAPTURED AT DUGONG BAY

A 14-FOOT MAN-EATING SHARK WHICH PROVIDED A RARE FEAST FOR THE MALAY CREW OF THE "CULWULLA"



WAVE-FRETTED ROCK IN CAMBRIDGE GULF

ROCK DRAWINGS IN THE FORREST RIVER DISTRICT WITHIN WALKING DISTANCE OF THE FORREST RIVER MISSION STATION

SORTING MOTHER-OF-PEARL SHELL

The pearl shell fished from the sea along the West Australian coast has brought up to $1,500 per ton, but of late years there has been a great fall in price—a drop of $750 on one occasion. Here the shells are being classed and thrown into several heaps. In the London market they are sold in five divisions, known as bold, medium, chicken, broken pieces, and wormy.

A TRIBE OF WEST AUSTRALIAN BLACKS ARMED WITH SPEARS, SHIELDS, AND BOOMERANGS

Their bodies are daubed with white clay; they often use red and yellow ocher. Many of the spears in this picture are 14 feet long.

THE CORROBOREE, A NATIVE CEREMONIAL DANCE

The Australian blacks have all kinds of ceremonies, some of a serious nature and others a matter of entertainment. They usually imitate the actions of animals and birds. Here they are performing an alligator dance. The figures squatting on the ground form the "ladies' orchestra." They keep time to the movements of the men by beating on their thighs, clapping hands, and sometimes striking the folded skins of animals, such as kangaroo or wallaby hide.

body. On the islands along this coast the practice has developed into a craze for so-called beautification of the body. The ridges are quite soft and velvety to the touch. The operation of surgical ornamentation of the men is often performed by the wives.

Some excellent pioneer work is being accomplished at Port George Mission by Messrs. Wilson and Paton, who, with their wives, have produced a veritable Garden of Eden, with tropical fruits, flowers, and vegetables. They have many goats and fowls. The surrounding country is well grassed and fed by fresh running streams.

The blacks in this section are reputed to be a quarrelsome lot, but Mr. Wilson reports that the quarrels are tribal affairs and he has never been molested. These aborigines carry a distinct strain of Malay blood, which is the case with many tribes on the northern coast of Australia, as Malays have frequented the northern seaboard for centuries in search of pearl shell and sea slugs (trepang), which find a ready sale in markets of the Far East.

Sea snakes are frequently seen curled up asleep on the surface of the water. These reptiles are poisonous and grow to about 12 feet in length.

The run from Admiralty Gulf to Napier Broome Bay is full of navigation difficulties, since many reefs and small islands abound.

NATIVES OF LONG ISLAND GROW HOSTILE

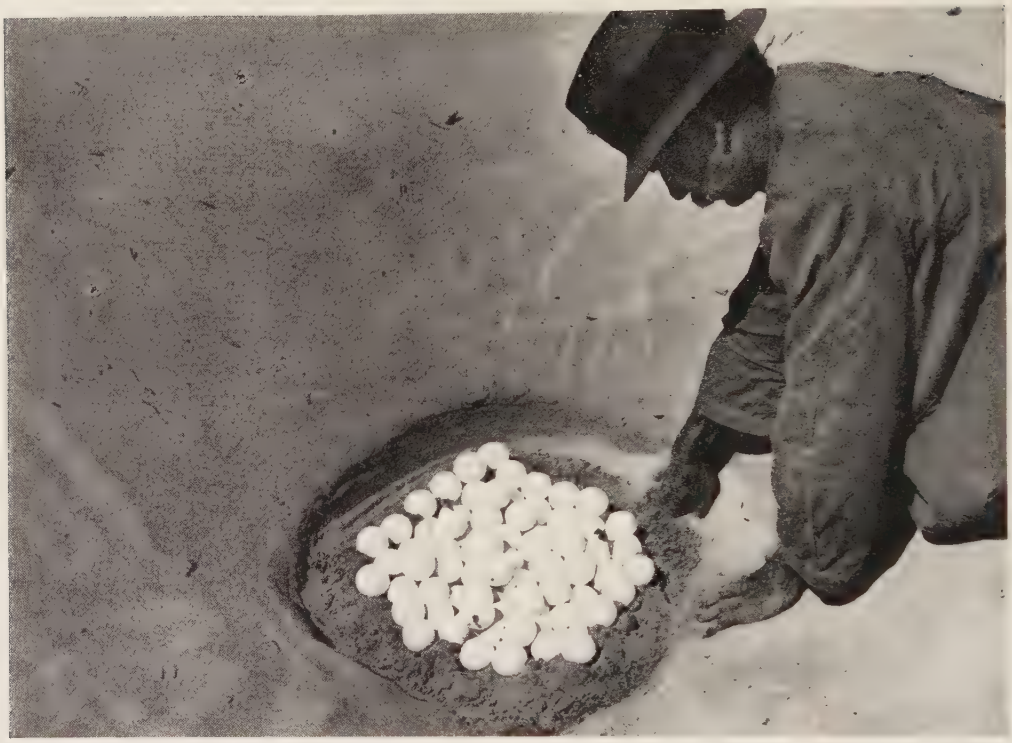
At Long Island several wild men were induced to come aboard the schooner. They were very tall and wore no clothing whatsoever, their only adornment being well-defined

"SAMSON"

A wild inhabitant of Camden Sound, Western Australia, who has won a reputation far and wide as a wonderful spear-thrower and a terrible fighter. Within the last few months news has filtered down the coast that he has killed three men. He is standing on a raft built of mangrove saplings which are held together by hardwood pegs.

AN AUSTRALIAN DUGOUT

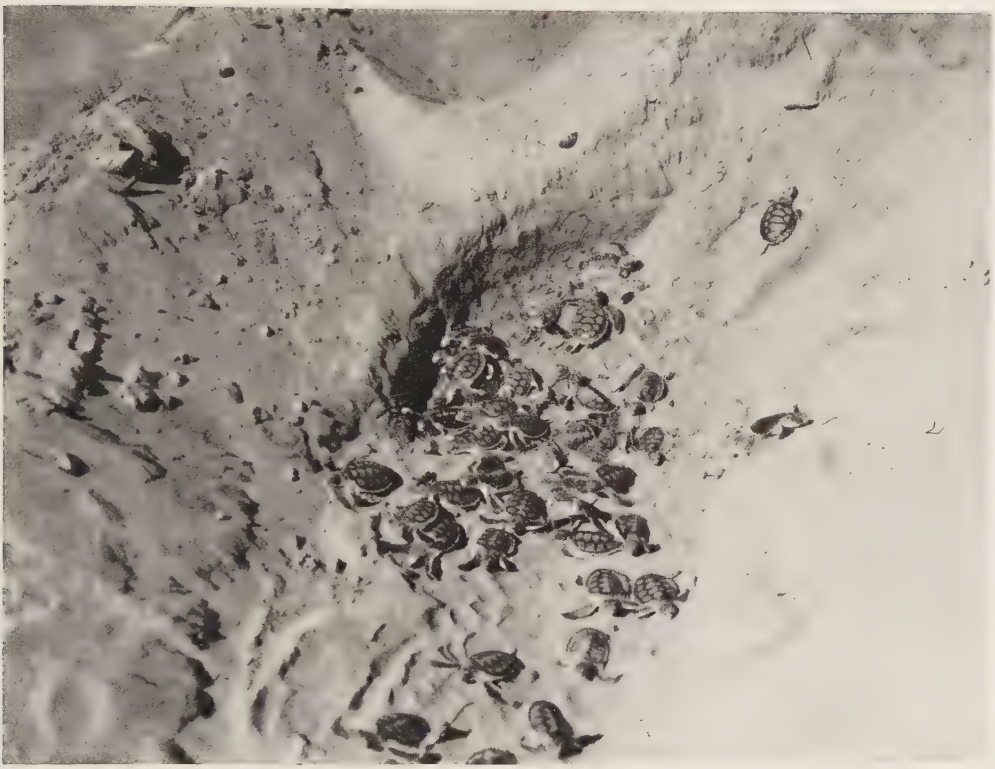
This rough craft is the result of burning and chopping out a solid log and pointing each end. It is 19 feet 6 inches long and has a beam of 18 inches. Though it is filled and surrounded with Montgomery Islanders, it was actually captured from a wild tribe which inhabits one of the many small islands on the northwest coast of Western Australia.



A TURTLE NEST; THESE EGGS ARE ABOUT THE SIZE OF TENNIS BALLS

Unlike the hen egg, they have a parchmentlike covering. As many as 200 eggs have been found in one nest. The natives find these nests by probing the sand with spears or sticks, the stain on a spear point indicating the incubator. The eggs are eaten raw by the blacks and are used in cooking by the whites of tropical Australia.

GIANT BLACKS WITH TURTLE EGGS



A NEST OF YOUNG TURTLES

When the eggs, which have been buried about two feet deep by the mother turtle, are hatched in the warm, dry sand, the little turtles fight their way upward and, once on the surface, make straight for the sea. Here the youngsters, measuring about three inches, are starting on their first expedition down to the sea.

TURTLES ON LACROSSE ISLAND, CAMBRIDGE GULF

FEMALE TURTLES MOVING TO THE SEA, AFTER BEING HELD PRISONERS ALL NIGHT

As they march they leave their "footprints" on the sands.

A RECORD TURTLE CATCH ON LACROSSE ISLAND

Four Sunday Island blacks captured 83 giant turtles on the beach at Lacrosse Island, in the Cambridge Gulf. They were caught at night, as they left the water to go ashore to lay their eggs.

AS WILD AS THE WORLD'S WILDEST

These inhabitants of a small island on the northwest coast of Western Australia live entirely in the open, build no huts, and when first approached by white men dashed into the scrub, later appearing armed with spears.

tribal markings and long chin whiskers. All conversation was carried on by means of signs, as even the blacks of our party could not make themselves understood.

Later, when nearly all hands went ashore, the attitude of the Long Islanders changed from one of friendliness to threatening hostility. They flourished their spears and seemed ready to attack. The Sunday Island boys explained that this change took place because their offer of women was neither appreciated nor accepted.

On the shores of Napier Broome Bay there is a small mission station, founded some 20 years ago by Spaniards of the same order which founded Beagle Bay Station.

It is rarely that a white visitor plants his feet in these parts, except about once a year, when the mission schooner brings supplies from Broome. Rice, tobacco, sugar, and tropical fruits are grown with success by the four Brothers. Eight half-caste boys, an old black fellow, and a gin constitute the entire population.

A MONTGOMERY ISLANDER'S ORNAMENTED BACK

This remarkable design is brought about by opening up the skin with a sharp shell and constantly rubbing in mud obtained from around the roots of the mangrove trees, which grow in salt water and fringe the coast of tropical Australia. It is said that this particular aboriginal has the finest body ornamentation on the Australian continent.

The Brothers are often attacked by hostile blacks, and two of them bear the marks of spear wounds received in these encounters. Wild dogs — dingoes — also trouble the little settlement.

Several great stingrays and a shovel-nosed shark were speared in the shallow waters of the bay. The stingray, sometimes reaching a weight of 600 pounds, is armed with a poisonous spear which protrudes from its thick tail, not quite halfway down. This spear is an extension of its spine and is used as a weapon of offense and defense. The sharks on this coast grow to an enormous size, often attaining a length of 30 feet.

THE ISLAND HOME OF GIANT TURTLES

In Cambridge Gulf, a small uninhabited island, known as Lacrosse, is the home of giant turtles. Here, in one night, the four Sunday Island boys captured 83 great turtles by turning them over on their backs. Every turtle was capable of

carrying a man, a feat which was proved when one of the biggest blacks of the party mounted and rode his turtle toward the sea. After reaching the water the turtle actually supported the man, who prevented it from diving by holding firmly to the front part of its shell and by throwing his weight on the tail end. Jackson obtained a splendid record of turtle life.

RANCHES SERVED BY CAMEL TRAINS

At the head of the gulf lies Wyndham, the port for the great cattle country of the hinterland. From Wyndham the cattle stations (ranches) are served by camel trains, which carry supplies for hundreds of miles into the interior. The camels are driven by Afghans. Camel teams are familiar sights in the streets of the little township, hauling in the great wagon-loads of firewood from the outlying district.

The first camels were brought to Australia for the use of the early explorers. Later a fine type of dromedary was imported for breeding purposes and it is this type of animal that is bred in central Australia. It is considered by many leading authorities to be the largest and strongest dromedary to be found in the world. It proves invaluable for pack work in waterless regions.

Wyndham is a typical Australian outback town—it boasts a hotel, hospital, butcher's shop, several stores, post office, and savings bank. The Western Australia Government has built a fine refrigerating plant here, and when in full swing it should give Wyndham an impetus.

On the Forrest River, which flows into Cambridge Gulf, Mr. and Mrs. Gribble are living at the Anglican Mission, founded for the uplift of the Forrest River tribes. Mr. Gribble has numbers of loofa vines growing, which provide a substitute for sea sponges. He ships his loofa sponges at Wyndham, whence they are taken to Perth.

Unlike many of the tribes to the south, who use the spear in the same manner that the ancient Greeks threw their javelins, the Forrest River men use a throwing-stick, or lever, known as a *womerah*.

By resting the spear on this flat lever, which measures about three feet in length, such an impetus is given to the throw that a good spear-thrower can hurl the weapon as many yards as he can throw it feet when hurling it javelin-fashion.

It is generally believed that every Australian black throws the boomerang, that peculiar curved stick so closely identified with the aborigines, but such is not the case. There are tribes which have never seen a boomerang. The blacks of this coast are particularly well set-up and well nourished types, hundreds of them standing nearly seven feet in height.

The trip from Broome to Wyndham and return required six months of strenuous work and navigation in the *Culwulla*. The expedition obtained much valuable information regarding the pastoral, fisheries, timber, and mineral wealth of this wonderland of the State. William Jackson secured the first comprehensive pictorial record by means of the "movie" and still cameras.

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THE STORY AND THE LEGENDS OF THE PONTINE MARSHES*

After Many Centuries of Fruitless Effort, Italy Is to Inaugurate a Gigantic Enterprise to Drain the Fertile Region Southeast of Rome

By Don Gelasio Caetani

Italian Ambassador to the United States

I AM not an expert in geography and I am not an explorer, though he who has lived for any length of time in Italy and takes interest in the beauty of my country truly could be called an explorer who never comes to the end of his task.

I will attempt to tell you something of a generally little-known region, quite close to Rome, called the Pontine Marshes. This strange corner of Italy has been the abode of my family for almost a thousand years and a large part of the land has belonged to us uninterruptedly since the year 1297.

Some of you may inquire where the Pontine Marshes are, but all of you certainly know something about the road that leads to them—the Appian Road, famous for the endless rows of old Roman funeral monuments that line it on both sides.

The Via Appia, built by Appius Claudius about 300 years B. C., starts from Porta San Sebastiano, the southern gate of Rome, and leads toward Naples. For the first 65 miles it runs as straight as a taut string, until it reaches the town of Terracina, where it passes under the cliff of Monte Sant' Angelo that overhangs the sea (see pages 358 and 360).

The Romans had to chisel off part of the rock to make space for the roadbed. After passing this point it makes a first bend and then goes to Naples.

When you leave the Eternal City on this classic road, you pass at first along a wonderful array of old Roman sepulchral monuments; then you climb up the Alban Hills, extinct volcanoes of prehistoric times, and from there you gradually descend upon a great plain, some 30 miles from Rome, known to history as the Pontine Marshes.

MOUNT CIRCEO, WHERE ODYSSEUS AND CIRCE MET

On the left, as you travel toward Terracina, are the olive-covered Lepine Mountains, of gray limestone, that at sunset are veiled by that beautiful purple haze one sees so often reproduced on the background of the early Renaissance paintings. To the right is the Tyrrhenian Sea, along the border of which runs a

*A lecture delivered before the National Geographic Society in Washington, D. C., January 25, 1924. The manuscript has been revised by Prince Caetani for publication in the National Geographic Magazine.

Photograph by Alinari

TERRACINA FROM THE SEA, AT THE BASE OF MONTE SANT' ANGELO

This promontory, rising to a height of 750 feet, is crowned by the remains of an imposing temple dedicated to Venus. Amber and leaden playthings, which Roman maidens used to dedicate to Venus before their marriage, have been unearthed here and are now to be found in the Thermal

Photograph by Alinari

TERRACINA, WITH MOUNT CIRCEO RISING IN THE BACKGROUND AND THE PONTINE MARSHES STRETCHING TO THE RIGHT

The Appian Way may be traced running through the town diagonally from near the upper right corner of the picture.

Photograph by Alinari

WHERE THE APPIAN WAY TURNS TOWARD NAPLES

"For 65 miles after leaving the southern gate of Rome, the Appian Way runs as straight as a taut string, until it reaches Terracina, where it passes under the cliff of Monte Sant' Angelo" (see page 357). The Gate of Napoleon is seen in the distance.

Photograph by Alinari

THE GROTTO OF CIRCÉ AT THE FOOT OF MOUNT CIRCEO (SEE PAGE 359)

It is here that legend says Odysseus went to the rescue of his companions, who had been treacherously transformed into pigs by the half-goddess Circe (see text below).

large sand dune covered by a wonderful oak forest some 30 miles in length. Between the dune and the sea is a series of lagoons.

At the extreme end a solitary mountain rises, to all appearances from the sea. It is Mount Circeo, the cornerstone of the Pontine Marshes. This mount was an island in bygone ages, as geologists have proved, and Homer, eight centuries before Christ, speaks of it in the "Odyssey" as an island, though probably it was not so any longer (see page 359).

Circeo was the scene of the legendary encounter between Odysseus and Circe, the sorceress.

After long and wearisome travels, the hero of the Siege of Troy lands with his companions on this rocky island, full of mysterious grottoes and caverns. Several of his men, while on a reconnoitering mission, are received in the wonderful palace of the half-goddess Circe, who treacherously gives them a drugged beverage which instantly transforms them into pigs. Odysseus goes to their rescue. With the help of Hermes he remains unharmed by the magic of Circe, and at the point of his sword obliges her to free his companions.

On the north side of the mountain the people still show a large grotto which is said to have been the haunt of the tricky goddess (see illustration above).

The large quadrangle formed by the foothills of the Alban volcanoes, by the Lepine Mountains, by the wooded sand dunes of the coast, and by Mount Circeo, measuring some 150,000 acres of extraordinarily fertile land, is known to history as the Pontine Marshes (see map, page 394). The water, hemmed in on all sides, cannot flow out.

In winter the mountain streams pour their foaming, muddy torrents upon this lowland, flooding thousands of acres; the rich mud slowly settles, coating the fields with a silt which is the finest of fertilizers; then the waters gradually flow out through narrow channels until, in summer, only the lowest portion of the land, that which lies practically at sea-level, remains in a swampy condition.

A dense, luxuriant growth of water

LONG-HORNED CATTLE OF THE ROMAN CAMPAGNA FIND IDEAL PASTURAGE ON THE PONTINE MARSHES AFTER THE WINTER WATERS HAVE SUBSIDED (SEE TEXT, PAGE 368)

plants springs up with the approach of the warmer season; the stagnant, lukewarm waters teem with life of every description, and toward the month of July the treacherous Anopheles mosquito drops its filmy larval veil, rises out of the marshes, and, flying around in search of a living for itself, sows death upon humanity. By stinging a malaria-infected person the mosquito infects itself, and then, stinging some healthy individual, it communicates to him the disease.

Malaria is not deadly in itself, but its repeated attacks so weaken the human organism that frequently fatal illnesses take hold of the fever-stricken body.

MALARIA HAS DRIVEN THE PEOPLE FROM THE PLAINS

The inundations in winter and the malaria in summer have driven the population out of the plain; but the unparalleled fertility of the soil entices some people back to defy the disease. The lowlands of the Agro Pontino are deserted; there are no cities or villages, but some lonely hamlets and, scattered here and there, farm buildings, in which only a few persons live in summer.

Many centuries ago most of the inhabitants fled to the mountains, built their towns on some steep hills, and from these vantage points made dashes into the plain to work the fields and tend the cattle.

Such a place was ancient Cori, founded by the Trojan Dardanos, with its city walls constructed of huge polygonal blocks and with its beautifully preserved Temple of Hercules (see pages 363 and 364).

A little farther on rose Norma, on the very edge of a vertical cliff 600 feet high, as ancient, if not more so, than the city of Rome. In olden times it was called Norba, and the cyclopean walls, formed out of huge, carefully trimmed boulders, are still a marvel to those who visit this not easily accessible place.

At the foot of Norma is the abandoned medieval town of Ninfa, the Pompeii of the Middle Ages, as Gregorovius called it, covered with ivy and brambles. This is one of the most poetic spots of the world (see page 373).

A little farther along the range is Sermoneta, with the thirteenth century castle

THE ANCIENT CITY OF CORI, ON THE EDGE OF THE PONTINE MARSHES

Photograph by Alinari

Founded, according to legend, by the Trojan Dardanos, this city (known in ancient times as Cora) still preserves remnants of its great walls, composed of huge polygonal blocks. It was almost wholly deserted early in the Middle Ages, but was rebuilt in the thirteenth century. Among its many interesting ruins is the Temple of Hercules (see illustration, page 364).

Photograph by Alinari

THE TEMPLE OF HERCULES AT CORI (SEE PAGE 363)

The name of this ruin is probably a misnomer. Inscriptions indicate that it was dedicated to Jupiter, Juno, and Minerva. A statue of Minerva, supposed to have been found here, now adorns the fountain in the Palace of the Senators at Rome.

of the Caetani towering on a high mountain spur and dominating the vast plain of the Pontine Marshes (see page 372). Then follow Sezze, Piperno, and other towns.

TWENTY-THREE TOWNS HAVE DISAPPEARED

These are the inhabited places today; but in olden times the whole land was densely populated and highly productive. Twenty-three towns are supposed to have existed where now one sees not the trace of a single building. The most famous of these cities which have disappeared was Pometia, conquered and sacked by the Roman King Tarquinius the Superb in the sixth century before Christ.

It is astonishing that not a trace is left of these towns — not a single crumbling wall or the foundation of a building. We do not even know exactly where Pometia was located. Of Tiberia, a town that grew up around one of the villas of Tiberius and flourished in the early Middle Ages, only a single piece of concrete foundation is left.

DUCK HUNTERS ON THE LAGOON OF FOGLIANO

Here the waterfowl come from the sea, seeking shelter and food (see text, page 367).

San Donato, a prosperous community that rose on the sand dunes near the sea, has completely disappeared. When in the year 1298 Peter Caetani took possession of this property he went from one building to the other, ostentatiously opening and closing the doors and touching the walls with his hands, as the ceremonial of those days required.

Now, as you go through the oak forests of San Donato, winding your way between the malaria-breeding ponds and the thorny brushwood, you do not see a single stone protruding above the ground. My mother made excavations on the spot and was fortunate enough to find the tomb of Camenius, the last pagan owner of this property, who died toward the middle of the fourth century of our era. The widow had had an inscription engraved on the large tombstone; in a few beautiful verses she recalls his high offices and expresses her sorrow at being left alone to bear the burdens of life.

Now, where the villa of Camenius rose the fishermen dry their nets. The lagoons are wonderful fishing grounds that have supplied Rome for two thousand years (see page 366).

As I said before, these lagoons have

FISHING BOAT HARBOR ON THE PONTINE LAGOON

"The lagoons are wonderful fishing grounds, that have supplied Rome for two thousand years."

THE PONTINE MARSHES AT HIGH WATER

In winter large tracts of land are submerged; in spring the waters subside and the fields are covered with grass and flowers (see text, page 368).

WASHING DAY: WOMEN OF THE PONTINE MARSHES DISTRICT UTILIZING THE LINEA CANAL, BUILT BY POPE PIUS VI

formed between the great prehistoric dune covered with oak forest and the more recent one thrown up by the sea.

There is no natural communication between the lagoons and the sea. When these lakes swell, during the rainy season, the fishermen cut a small ditch across the dune, and the waters, rushing out to the sea, in a few hours widen to a broad river. The fish taste this lukewarm, brackish water and swim by the thousands and millions into the lagoon, where they are caught.

This locality is also a wonderful shooting resort, where our friends go at dawn to hide behind the blinds on the water's edge. There the ducks come from the sea, seeking shelter and food in that maze of ponds and canals distributed throughout the dense growth of reeds (see illustration, page 365).

The complete disappearance of the old cities of the Pontine Marshes is not difficult to explain. The whole zone is alluvial ground, formed of clay, sand, and thin gravel; you cannot find a single stone in a ten-mile circle. Therefore every abandoned building, every piece of ruin, becomes a precious quarry for the construction of new buildings, and the necessities of the later population have completely obliterated the monuments of former civilizations.

THE APPIAN ROAD DISAPPEARED BENEATH WATER

As I said before, at the time of the Roman Republic, in the fourth and fifth centuries B. C., the Pontine region seems to have been free of waters, healthful, and densely populated. Then, a little before 300 B. C., near the time the Appian Road was built, something happened that has not been fully understood.

The natural outlet of the waters in the depression between the city of Terracina and Mount Circeo was obstructed, probably through some seismic movement; a raising of the ground a few feet was quite sufficient to stop the outflow of the waters, and the sea increased the obstruction by piling up sand dunes.

In this way the great plain of Pometia became hemmed in on all sides by higher lands and converted into a large basin, into which the waters naturally converged

WATER BUFFALO IN ONE OF THE CANALS OF THE PONTINE MARSHES

These African beasts are said to have been brought to Italy by the Carthaginians under Hannibal (see text, page 371). While they make acceptable beasts of burden (see opposite page), they perform their greatest service to man during their "hours of leisure," when disporting in the marshes, for it has been found that they are the most effective agency in ridding the irrigation and drainage canals of clogging aquatic plants, which they uproot with their hoofs.

from everywhere, but from which they could not flow except through the narrow channels dug near Terracina to connect the marshes with the sea.

The ground became water-soaked. The great Appian Road, not a long time after being built, began to sink in places and had to be raised by Trajan and other Roman emperors. During the eighth century it went completely under water and the road from Rome to Naples had to be shifted to the foothills, passing near Ninfa and Sermoneta. From that time to the present this waste but fertile region became the playground of unruly waters.

ATTEMPTS TO DRAIN MARSHES HAVE EXTENDED OVER TWENTY-TWO CENTURIES

In winter large tracts of land are submerged under the yellow waters, which often rise as high as the tops of the fences; ducks, sea gulls, and geese make it their home, diving in the shallow water for food.

In spring the waters subside and the fields become covered with a luxuriant growth of grass and flowers, where the sheep and the long-horned cattle of the Roman Campagna find ideal pasturage (see page 362).

For 2,200 years the rulers and the people of Rome have vainly tried to drain the marshes.

The first serious attempt was made by the Consul Cornelius Cethegus, about 185 B. C.; but the work was discontinued during the civil wars between Marius and Sulla (88 B. C.) and between Cæsar and Pompey (48 B. C.).

Julius Cæsar made vast plans, which were, however, abandoned after his assassination (44 B. C.).

Nerva and Trajan worked at the restoration of the Appian Road that was sinking; then came the decline of the Roman Empire, and we read of no reclamation projects until the end of the fifth century, when Theodoric, King of the Ostrogoths, intrusted the work of draining the marshes to the patrician Decius, who successfully accomplished it.

There is a most remarkable piece of work to be credited to the Romans of these first centuries, but nobody knows exactly to whom. It is the Rio Martino.

WATER BUFFALO DRAWING CARTS OF HAY

As mentioned before, the marshes are separated from the sea by a prehistoric dune some three miles wide and a hundred feet high. The Romans, with great daring and with an enormous expenditure of labor, dug right through this dune at sea-level, and this gigantic cut, with the sides over a hundred feet high, appears to-day, a strange rectilinear valley traversing the oak forest.

A LAWSUIT THAT LASTED 560 YEARS

However, all these works proved ineffectual. The condition of the Pontine land became worse and worse. The waters could not find sufficient outlet and during the rainy season inundated large tracts of land. Each group of inhabitants, therefore, strove principally to divert the waters from their own properties to those of their neighbors.

Lawsuits were instituted and wars broke out incessantly in every direction. Our family, as lords of Sermoneta and in the interest of our people, had to quarrel with the neighboring community of Sezze, and from this resulted the longest lawsuit that exists, I believe, in the records of Italy. It started about the year 1230 and ended about 1790, with the draining of the marshes by Pius VI. For about 560 years, therefore, this suit was carried on, with no period of intermission exceeding 20 or 30 years. When the decisions of the courts did not suit the people, they resorted to arms, and many bloody battles were fought.

The stronghold of Sermoneta was the powerful castle of the Caetani. Perched on top of a rocky mountain, strongly fortified with towers, creneled walls, and drawbridges, it could safely defy any enemy (see illustrations, pages 370, 372).

Pope Alexander VI confiscated it from our family, charging that we had unwarrantedly waged war on Sezze, but really for the purpose of giving the large Caetani estates to his son, Cesare Borgia, the Duke of Valentinois, for whom he had its fortifications greatly strengthened.

Alexander gave the castle itself to his daughter, the famous Lucrezia Borgia, who became the first duchess of Sermoneta, and the great halls of the castle have surely seen passing under their vaulted ceilings this beautiful woman, on whom popular belief has piled infamous accusations that historians have never been able to prove (see illustration, page 370).

When Alexander had completed the

ENTRANCE TOWER OF THE CASTLE OF SERMONETA, ANCESTRAL HOME OF THE CAETANI FAMILY

The quarrels in medieval times between the lords of Sermoneta and the neighboring community of Sezze resulted in the longest lawsuit of Italian history—from 1230 to 1790 (see page 369).

INTERIOR OF THE CASTLE OF SERMONETA

These walls have echoed to the footfalls of the famous Lucrezia Borgia, to whom Pope Alexander gave the castle, creating her the first duchess of Sermoneta.

THE OLD MUNICIPAL HALL OF NINFA, NOW THE AUTHOR'S PRIVATE HOUSE (SEE ILLUSTRATION, PAGE 373, AND TEXT, PAGE 374)

improvements and the fortifications of the castle, the Duke of Valentinois, according to Sanudo, took it away from his sister, saying, "She is a woman and can't hold it."

MANY POPES HAVE TRIED TO REDEEM THE LAND

It is impossible to enumerate all the attempts made by the Popes to drain the marshes. The space allotted to me is not sufficient.

Our family Pope, the great Boniface VIII, made some fruitless attempts in the year 1301; so did Martin V, of the Colonna family, about the year 1420. Then came Eugene IV and Leo X; the latter gave large grants for this purpose to his nephew, Giuliano dei Medici, in 1514, who made a serious attempt to carry through the work.

Urban VIII, about the time the *Mayflower* landed on the New England shores, intrusted the work to a Dutchman, Cornelius Wit. Our family made a similar attempt about that time and brought 200 families from Holland to Ninfa. They only stayed a few years, and those who survived the malaria fled and never showed up again. An attempt at colonization with Albanians was no more successful.

At last, in 1777, Pope Pius VI accomplished the most successful work on record.

He dug a large canal along the Appian Road and regulated the flow of waters by a network of canals. A large part of the land was drained and the Appian Road of the centuries emerged again from the waters.

But even this great effort only partly improved conditions.

WATER BUFFALO FIGHT FOR MAN

Strange to say, one of the principal difficulties in controlling the waters is caused by the aquatic plants that grow in the canals. In the space of a very few weeks these become so dense that the ditches are completely choked. Thus far no practical way has been found to eradicate these plants.

The most effective means of combating this menace, a very ancient one, too, is to employ buffalo—an African species,

THE CASTLE OF SERMONETA OVERLOOKING THE PLAIN

Perched on top of a rocky mountain, strongly fortified with towers, crenelated walls, and drawbridges, it defied all enemies for hundreds of years (see text, page 369, and illustrations, page 370).

THE TOWER OF PRINCESS NINFA, WITH NINFA LAKE IN THE FOREGROUND

These ivy-clad ruins date from the twelfth and thirteenth centuries. The adjacent town was destroyed during the wars of the Great Schism of the West in 1381 and not rebuilt on account of the malaria (see the legend of Malaria, page 374). A few miles from Ninfa was ancient Tres Tabernæ, where the Apostle Paul was met by friends from Rome after his shipwreck on the island of Malta (see Acts xxviii: 15).

which is supposed to have been brought over by Hannibal about 200 B. C.

These animals breed wonderfully in the marshes. They are driven into the canals, where they swim about with evident satisfaction, and while paddling around uproot the plants with their hoofs.

When their services are not thus employed, they haul heavy loads and intelligently perform their duties, directed by the voice of their driver (pp. 368, 369).

New Italy intends now to tackle the problem of draining the marshes that has baffled each succeeding generation for more than two thousand years. The Government is approaching it with all the means and technical knowledge of modern times and will accomplish the work.

The ancient canal of Rio Martino will be opened again, the mountain streams will be placed under control by building a reservoir at the foot of the mountains, and large pumping stations are to be erected for draining the swampy land that is practically at sea-level. I am sorry that there is not space for me to go into the details of this gigantic enterprise, which will cost upward of three hundred million lire.

THE LEGEND OF MALARIA

Meanwhile the derelict region is hopefully waiting. There lies romantic Ninfa, one of the most conspicuous victims of malaria. The deserted street winding between the houses and the towers and churches in ruins tell us the tale of a population that fled to the mountains to escape death.

The city walls that withstood many attacks have crumbled beneath the onslaught of the elements, and the only building that still is habitable is the municipal hall, which I have transformed into my private dwelling (see page 371). In front of it flows the crystalline river Ninfa that, a few yards distant, springs out of the rocks at the bottom of a charming little lake and flows through the abandoned city, while branches of ivy, brambles, vines, and roses hang down from the ruins to play in the running water.

Romantic Ninfa has created a charming legend that I wish to relate to you, as it symbolizes the malaria. It is quite an old legend.

Once upon a time there was a king who was lord of all the Pontine Marshes. He had a beautiful daughter, Ninfa. Happy he would have been if his kingdom had not been swamped by the waters and infested by the malaria.

Two kings came to woo the beautiful Ninfa; they were King Moor and King Martino. The father said: "I will give the girl to him who first succeeds in draining the water off my land."

King Martino called all the men of his kingdom and set to work digging out the Rio Martino, that big canal which I mentioned previously (see page 368). King Moor did nothing but court the beautiful girl. She, however, loved the man who was working so hard to win her.

When King Martino was about to finish his great canal, Ninfa one day said a few sarcastic words to King Moor on account of his laziness and told him how glad she was to be sure now that she would become King Martino's wife.

Without a word King Moor raised a magic wand and waved it toward the distant Mount Circeo, saying: "Flow off, waters, flow to the sea!" and immediately the waters started toward the south, and in a few hours the land was dry.

The girl's father, in accordance with his promise, had to give Ninfa to King Moor; but the beautiful maiden was so grief-stricken that she fled to a little lake that now bears her name. She climbed to the top of the high tower that rises on the edge of the water, and from the embattlements, with a cry of despair, threw herself into the opal-blue water below.

But Ninfa did not die. She still lives in the depth of the waters, among the long algæ that rise from the silt, and she makes her abode in that big cavern that is at the bottom of the lake, from which the water gushes out in big waves.

There she remains in hiding during the day, and only at sunset, when the malaria is most treacherous, she comes to the surface of the water near the road and suddenly shows herself to weary young men who are returning to their homes after their daily tasks.

The young men stop amazed and gaze at this wonderful figure, but misfortune befalls them, for instantly they wither and grow old.

This is the legend of Ninfa, the sad legend of the malaria.

Photograph by Donald McLeish

THE COLOSSAL STATUE ERECTED TO SAINT CARLO BORROMEO AT ARONA, ON LAKE MAGGIORE

This celebrated cardinal-archbishop, famous for his labors among the plague-stricken inhabitants of Milan, was born in Arona in 1538. The statue is 75 feet in height and stands on a pedestal 42 feet high. A stairway leads up the interior of the figure and the visitor may climb to the head. The head, hands, and feet are of bronze and the robe is of wrought copper. It was Cardinal Carlo who consecrated the great cathedral of Milan in 1577 (see page 381).

Photograph by Donald McLeish

VENETIAN TRADING BOATS CROSSING THE LAGOON FROM MALAMOCCO TO VENICE

The town of Malamocco, five miles from Venice, is situated near the site of the island of the same name, which was formerly the capital of the confederacy of islands that gave birth to the Republic of Venice. The government of the confederacy was removed from Malamocco to the island of Rivoalto (Rialto) in 811. Thus Venice was founded.

Photograph by Kilophot

ARCO AND ITS CASTLE

Said to have been built either by the Romans or by Theodoric the Great, king of the Ostrogoths, this castle overlooks the town of Arco, on the banks of the Sarca, which flows into Lake Garda. As a winter resort, Arco is attractive. Roses bloom out of doors even in December, almonds ripen in February, and peaches, apricots, and pears appear in March.

Photograph by Donald McLeish

PEASANT CHILDREN OF THE STRONA VALLEY, NORTHERN ITALY

The Strona, rising near the Swiss border, flows into the Lake of Orta, a lovely body of water a few miles west of Lake Maggiore.

Photograph by Donald McLeish

"TAKING THE WATERS" AT THE VILLAGE FOUNTAIN

These children live in the little town of Orta, on the banks of the charming lake of the same name (see also pages 378 and 380).

Photograph by Donald McLeish

SAN GIULIO, A BEAUTY SPOT OF NORTHERN ITALY

A view of the Lake of Orta from a summit above the town of Orta, showing the island of St. Julius, with its monastery and church. The latter was founded by St. Julius, who came to this region to convert the natives in 379 A. D.

Photograph by Donald McLeish

"THE ANGEL OF MILAN"

One of the 2,300 marble statues which adorn the 135 spires of the world's third largest cathedral. Two hundred feet below is seen the entrance to the Galleria Vittorio Emanuele, the largest and loftiest arcade in Europe.

Photograph by Kilophot

THE CASTLE TOBLINO, ON LAKE TOBLINO, NORTHERN ITALY

One of the lake resorts which was returned to Italy by Austria under the provisions of the St. Germain Treaty in 1919.

Photograph by Kilophot

THE HARBOR OF RIVA, ON LAKE GARDA

This delightfully situated town belonged to Austria for more than 100 years—from 1815 until the signing of the Treaty of St. Germain, by which Austria restored the Trentino to Italy (see also pages 382 and 384).

Photograph by Kilophot

MOUNT CALVARY, OVERLOOKING CASTELROTTO

When this town belonged to Austria, prior to 1919, it was known as Kastelruth. It is the old Roman stronghold, Kastellum Ruptum, set on a green knoll with a grass-grown belt of masonry. Below is a crooked lane of houses with high-pitched gables and out-thrust windows all askew, projecting signs, and frescoed saints. The medieval costume for the men of the town is a resplendent sight—shoes of white leather with broad red tongues, plum-color coats faced with scarlet, and hats of yellow felt, gay with ribbons, flowers, feathers, and gold lace. This hill is the scene of religious

Photograph by G. R. Ballance

A ROUGH SEA AT BORDIGHERA, ON THE ITALIAN RIVIERA

Bordighera is only three and a half miles east of Ventimiglia, at the French frontier. It is famous for its roses, carnations, and anemones, and for palm branches, which are bleached on the trees and sold to the churches of Italy for Palm Sunday.

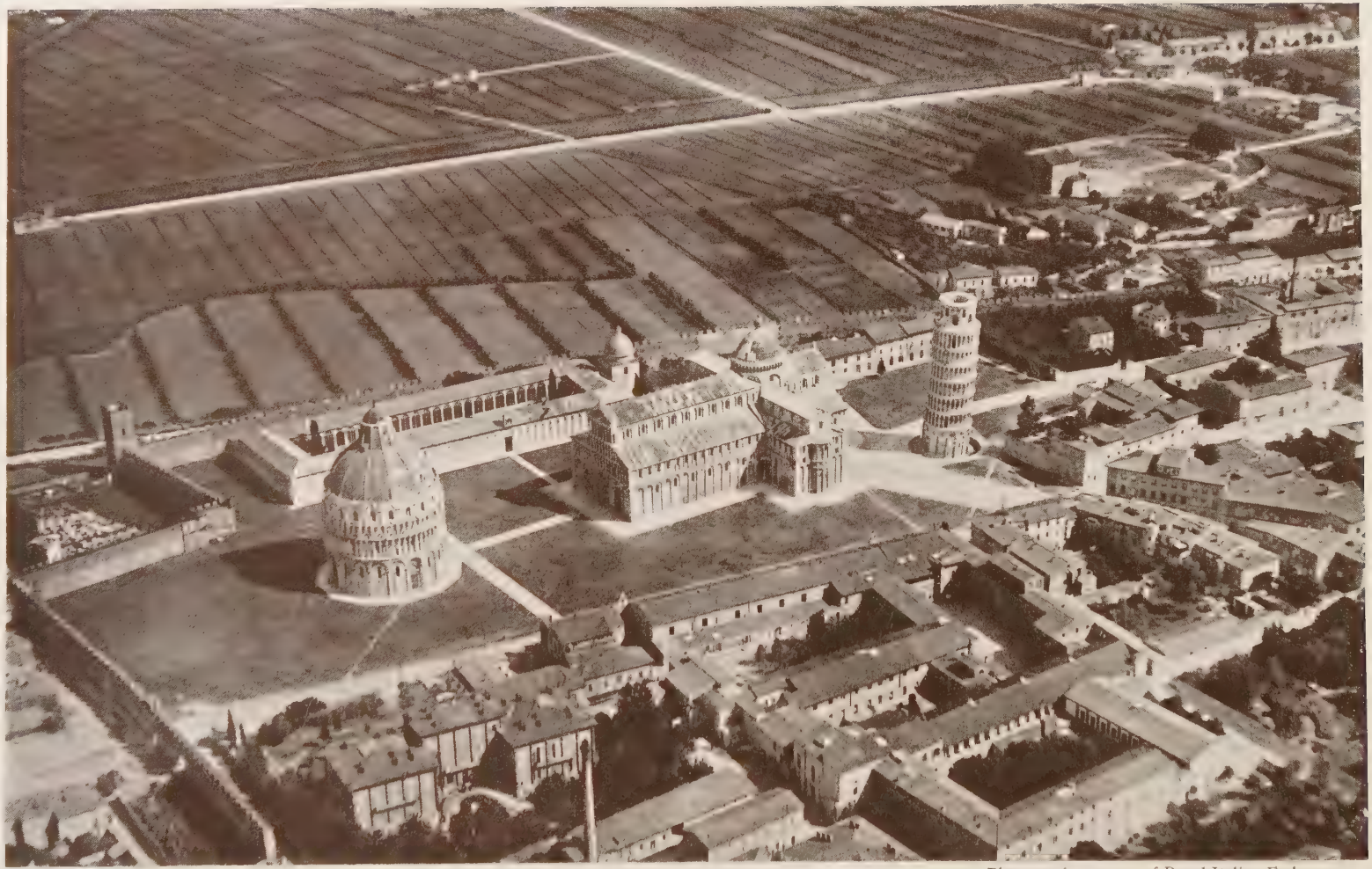
Photograph courtesy of Royal Italian Embassy

PALERMO, METROPOLIS OF SICILY, PHOTOGRAPHED FROM THE LATE DIRIGIBLE "ROMA"

This beautiful city has been coveted by many nations. It was originally a Phœnician settlement and for centuries was the head of the Carthaginian dominion in Sicily (see pages 391-423). Romans, Ostrogoths, Arabs, Byzantines, Normans, Germans, French, Spaniards, and Italians have held sway here. At one time Hamilcar, the Carthaginian, was encamped for three years on Hierete, or Pellegrino, the rocky eminence in the background, in a vain effort to dislodge the Romans from the city.

Photograph courtesy of Royal Italian Embassy

ROME: A VIEW OF ST. PETER'S FROM THE AIR. THE VATICAN AND THE PAPAL GARDENS ARE TO BE SEEN IN THE RIGHT BACKGROUND



Photograph courtesy of Royal Italian Embassy

PISA SEEN FROM AN AIRPLANE

The beautiful circular structure to the left is the 12th-13th century Baptistery, built almost entirely of white marble; in the center is the Cathedral, also of marble, and to the right the Leaning Tower, one of the Seven Wonders of the ancient world.

Photograph courtesy of Royal Italian Embassy

VESUVIUS IN ERUPTION

The world's most famous active volcano as seen from a dirigible.

Photograph by Donald McLeish

THE ANCIENT CHAPEL AND MAUSOLEUM OF THE GONZAGAS, NEAR BELLAGIO, OVERLOOKING LAKE COMO

In the distance rises Monte Crocione. This is one of the most celebrated beauty spots among the lakes of northern Italy.

ANCIENT CARTHAGE IN THE LIGHT OF MODERN EXCAVATION

By Count Byron Khun de Prorok

FEW sites of antiquity have a more illustrious history than the peninsula on which lie the accumulated ruins of the dead cities of Carthage. Phœnicians, Berbers, Numidians, Romans, Vandals, Byzantine crusaders, and, lastly, the Arabs have all left their traces, and to-day in the strata of thirty centuries lie the mute evidences of long racial warfare and the dethronement of past splendors.

Here, where peace now reigns over the marble dust, is a natural beauty and grandeur equal to any of the famous scenes along the Mediterranean shore, and the panorama viewed from Cape Carthage explains Queen Dido's selection of the site, in the ninth century B. C., for the first Punic city of Carthage.

From the summit of the ancient hill called Byrsa (meaning "hide," and reminiscent of the Dido story of the bull skin, see page 398) is unfolded the landscape which was once the scene of the great tragedy of the Mediterranean. To the east lies the magnificent Gulf of Tunis, of azure blue shading off into emerald green near the shores (see map, page 394).

On the opposite bank rise the majestic twin summits of the sacred mountain of the Carthaginians, the Bou-Kornein (see page 399). There stood the temple dedicated to Baal, but only a few stones mark the spot where the flames of votive offerings once paid homage to the insatiable Phœnician gods.

To the south, in an amphitheater surrounded by purple mountains, its hundred minarets reflected in the Tunis lagoon, lies "the White Mantle of the Prophet," as the Arabs call the city of Tunis to-day (see Color Plates, pages 415 to 422).

The picturesque village of Sidi-bou-Saïd crowns the northern promontory of Cape Carthage (see illustration, page 395). It looks somewhat like a white dove, the sacred symbol of the Carthaginians, for its roofs and domes spread out like wings above the blood-red precipices that stand sentinels above the entrance to the Gulf of Tunis.

This is the scene so often gazed upon by Dido, Pyrrhus, Hasdrubal, Hamilcar, Hannibal, Scipio, Cæsar, Cyprian, Augustine, Genseric, and St. Louis, and its history is made still more eloquent by the resurrection of its buried ruins.

The excavation of Carthage is difficult because of the great topographical changes that have taken place since Punic days. For these changes the Medjerda River is responsible to a considerable degree, as its alluvial deposits have encroached upon a large part of the peninsula, completely covering a portion of land which in all probability was once occupied by the city. To-day the Arabs still call these marshes Bahar el Azrag, meaning "the Blue Sea."

WHERE THE MIGHTY FLEETS OF THE CANAANITES ANCHORED

From motion-picture films taken by airplane last summer it is quite evident that there are vast submarine walls at Cape Kamart, to the northwest of the peninsula (see map, page 394). Excavations at this point, it is believed, will throw some light on the old baffling mystery as to the site of the Punic ports, where the mighty merchant fleets of the Canaanites plied to and fro. (As may be remembered, the Phœnician, whose Roman name was "Punicus," was a native of Canaan, in the lowlands of Palestine, prior to the invasion of the Jews.)

According to the descriptions of Appian and other Roman historians, we know the ports to have been circular at one time, with the admiral's military palace in the center, and at another period quadrilateral. It is said that as many as 220 galleys could be anchored at one time in the harbor. Actually a series of harbors, they were of imposing architecture and were marked off by gigantic columns, between which the ships were moored.

The sea has risen three and one-half yards since Roman days, and there are many ruins under water in the gulf and at La Marsa, north of the rebuilt city.

Photograph by Maynard Owen Williams

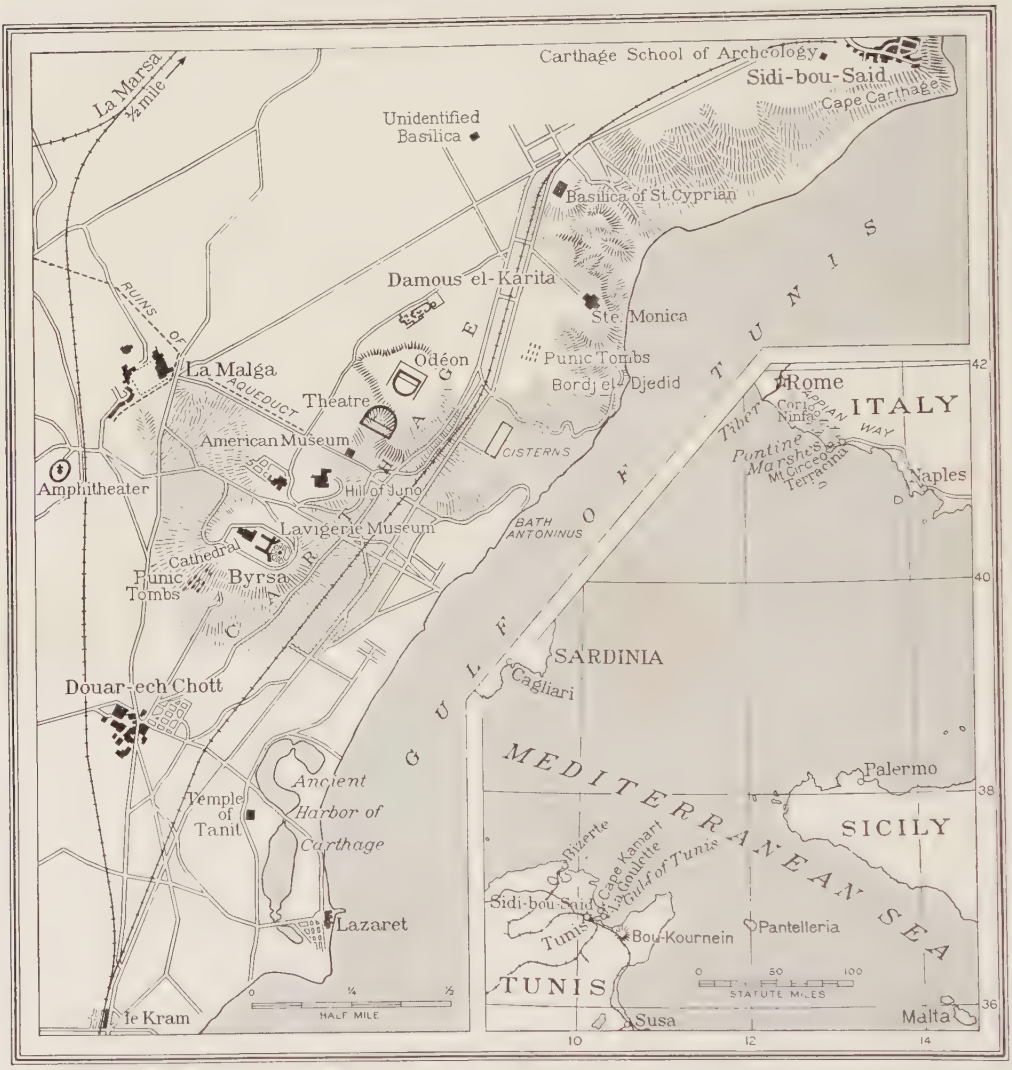
THE PUNIC PORTS AND A MODERN FISHING FLEET FROM LA GOULETTE BECALMED IN THE EARLY MORNING

These Arab dhows are passing to-day in the tracks of the ancient fleets of Carthage, Rome, Byzantium, the Vandals, and the Barbary pirates.

Photograph by Maynard Owen Williams

LOOKING SOUTH FROM THE BYRSA

Authorities differ as to the origin and date of the masonry here shown. It is probably not Punic, but Roman. From this point one has an excellent view of the Punic ports in the plain.



Drawn by A. H. Bumstead

A SKETCH MAP OF THE SITE OF CARTHAGE: ALSO THE PONTINE MARSHES (SEE P. 357)

Another obstacle in the way of excavation at Carthage is the alluvial deposits in the hollows between the hills. Here has been an accumulation of earth, sand, and débris at the rate of a *yard a century*. It requires little imagination to appreciate the difficulty of uncovering an edifice buried, say, twenty centuries ago. It is reported that Lord Carnarvon moved 70,000 tons of earth before reaching Tutankhamen's tomb. At Carthage it is singularly impressive to find the traces of so many different peoples, and in this respect no other spot in the world discloses so grippingly the war tragedy of the human race.

The question of when the Egyptians may have occupied this territory can be solved only by the most laborious and prolonged research, since Cambē, the city of the Sidonians, was founded by them six centuries before Dido (really Elissar, daughter of King Mathan of Tyre) settled there with her fugitive Phœnicians, prior to 800 B. C. Cambē was merely a ruin at this time, and history affords nothing beyond the fact of its existence and origin. Sidon had been the principal

LOOKING EAST, TOWARD THE MINARET OF SIDI-BOU-SAÏD

The foreground is a cement surface for catching rain water, probably much the same sort of rain-catcher that was used in ancient Carthage before Hadrian completed the Zaghouan Aqueduct. According to Moslem tradition, Saint Louis (Louis IX of France) before his death embraced Islamism and took the name of Bou Saïd.

Photographs by Maynard Owen Williams

CISTERNS OF LA MALGA, PROBABLY DATING FROM THE PUNIC PERIOD

These cisterns, open to the sky, were at first used for rain water, but when Hadrian built the 80-mile aqueduct from Zaghouan they served the Romans as storage tanks. Now they are used as storehouses and dwellings by the miserable inhabitants of the village.

Photograph by Maynard Owen Williams

THE BATHS OF ANTONINUS

Looking north along the seashore. In the upper left corner is seen a part of an old fort on Bordj el-Djedid, a hill where many tombs have been brought to light by excavators.

Phœnician seaport; so the Carthaginian people held their section of what is now Tunis as far back as their African history has been revealed.

ONCE A CITY OF A MILLION PEOPLE

Under the Barcas family (Hasdrubal, Hamilcar, Hannibal, etc.) Carthage was a great center of wealth and commerce, with a population which has been estimated variously between 700,000 and 1,000,000.

A good impression of what the city may have been in Hamilcar's day is obtainable from that greatest of French historical novels, "Salammbô," by Flaubert. Its immense palaces and temples in astonishing number were the envy of other nations, and a great triple wall was built to protect the city on the land side. It was from 50 to 60 feet high and more than 30 feet thick, with casements at the ground level for 300 elephants, and above these stalls for 4,000 horses, vast storage space for food and supplies, and quarters for 24,000 men.

Photograph from Byron de Prorok

VISITORS AND EXCAVATORS AT THE UNCOVERING OF THE GRAND MOSAIC OF THE BATHS OF GARGILIUS (SEE ALSO PAGE 406 AND TEXT, PAGE 408)

On the lower level, from left to right, are Fred Singer, attaché of the American Embassy at Paris; Princess de Cystria, Countess de Prorok, Mrs. Singer, Count de Prorok, Prince de Cystria, and Père Delattre.

The buildings of Carthage prior to its destruction by the Romans, in 146 B. C., were in some cases seven stories high.

From the accounts of Cato the Elder, the implacable foe of the city, whose "Delenda est Carthago" is unforgettable, the construction of the city must have been of admirable soundness—in fact, such that the conflagration of sixteen days can scarcely have demolished entirely the gigantic edifices and strong foundations. Part of these we expect to find intact at a great excavated depth.

CARTHAGE WAS NOT COMPLETELY DESTROYED

The utter devastation and obliteration of Carthage which for centuries following the Punic wars were thought to have taken place have been recently contradicted by exploration. Over the ruins long untouched dirt and sand had drifted, but mercifully preserving innumerable objects of art which escaped destruction.

Twenty, forty, and sixty feet below the surface have been unearthed the vestiges of the Byzantine, Roman, and Phœnician occupations. In this work have been engaged the explorers Gauckler, Merlin, and Poinssot, of the Service des Antiquités, but the most notable efforts have been those of Père Delattre (see above), who, with exceedingly meager resources, has labored over the ruins for fifty years. He has discovered four of the earliest Christian basilicas, Roman and Punic necropolises, an amphitheater, and many priceless relics, but during this long period of arduous search he has actually explored only one-tenth of Roman and Christian Carthage.

My own expedition has thus far more than justified the effort spent for four years. Remains previously located by Père Delattre have been completely excavated. Winter before last I continued the late Jules Renault's excavations, penetrated several strata and came across Arab tombs, a Christian chapel, Roman

Photograph by Soler, Tunis

THE BYRSA, OR CITADEL, AT CARTHAGE

Legend says that when Dido landed here she bargained with the natives for as much land as might be inclosed by the hide of a bull. The sale having been made, she ordered the hide cut into the thinnest strips possible and with these surrounded a site upon which she erected a citadel, calling it the Byrsa (from a Greek word meaning the hide of a bull). Modern buildings and villas on the site of Carthage are a source of great distress to the archeologists, who long to delve beneath all this area.

Photograph by J. Deconcloit

THE NAVAL AND COMMERCIAL PORTS FROM THE HEIGHTS OF THE BYRSA

Across the inner curve of the Gulf of Tunis is Bou-Kornein, the sacred mountain where stood the Carthaginian temple dedicated to Baal (see text, page 391).

Photograph by Maynard Owen Williams

ONE OF THE BOYS WHO HERD GOATS AND CATTLE ON THE HILLS AROUND THE BASILICA OF SAINT CYPRIAN (SEE ALSO PAGE 403)

cisterns, Byzantine relics of variety, marvelous mosaic floors, and beneath them Punic tombs of 700 B. C.

A TEMPLE WHERE CHILDREN WERE BURNED ALIVE

All the earth dug up at Carthage is carted away and passed through sieves. As laborious as this latter process is, it has been rewarded by the recovery of many coins, crystals, emeralds, beads, etc.

The most sensational discovery lately was the Temple of Tanit by the amateur archeologist, M. Icart (see pages 408 and 409), where human sacrifices were offered by the Carthaginians to the goddess of that name and to Baal Ammon. Literally hundreds of urns were found containing the bones of children from four to twelve years of age who had been burned alive.

The clew which led to this important climax of our efforts was supplied by an Arab, who was seen digging for stone inscriptions near the location of the Punic ports (see illustrations, pages 392 and 402) for the purpose of selling them to tourists. We undertook operations near by and found inscriptions to the deities

Photograph by J. Deconcloit

THE MARBLE CROSS ERECTED BY CARDINAL LAVIGERIE IN THE ROMAN AMPHITHEATER

It is sacred to the memory of Saints Perpetua and Felicitas (see below). In the distance is the Cathedral of Saint Louis on the Byrsa.

Photograph by Maynard Owen Williams

RUINS OF THE ROMAN AMPHITHEATER AT CARTHAGE

This arena, almost as large as the Colosseum at Rome, was used for wild-animal exhibitions and other brutal spectacles, and it was here that Saint Perpetua and many of her companions were torn to pieces by lions under Septimius Severus, in 203 A. D. In the center of this pagan amusement place is a chapel commemorating the early Christian martyrs (see above).

Photograph by Maynard Owen Williams

LOOKING SOUTH FROM THE RUINS OF THE PUNIC ADMIRALTY

The white-domed marabout (tomb) stands near the place where the circular naval harbor, the remnants of which are seen in the foreground, was joined to the commercial harbor, whose waters can be seen beyond. There is little question that these walls are Punic work, dating from the time when Carthage was the cruel mistress of the seas, maintaining the Phœnician tradition for close dealings.

mentioned and a large field of stiles bearing the pagan symbol of fertility, a crescent reversed over a disk or triangle.

Below this site were the urns, which were about twelve inches high, of red or white terra cotta, with handles and wide mouths sealed with yellow clay. Besides the bones of children were those of lambs and birds here and there. The name of the child sacrificed appeared on the stile immediately above.

Small wonder that the prophets of Israel spared no invective against Baal! Altars, pillars, and capitals with Phœnician carving were also found, and again appeared the crescent and triangle of Tanit, the bull head or a crude replica of the goddess.

I am hopeful of finding the statue of Baal Moloch in this sanctuary—that terrible idol into whose flaming interior were thrown so many Carthaginian children by

SOME OF THE COLUMNS OF A TEMPLE RECENTLY EXCAVATED BY THE SERVICE DES ANTIQUITÉS AND NOT YET IDENTIFIED

Photographs by Maynard Owen Williams

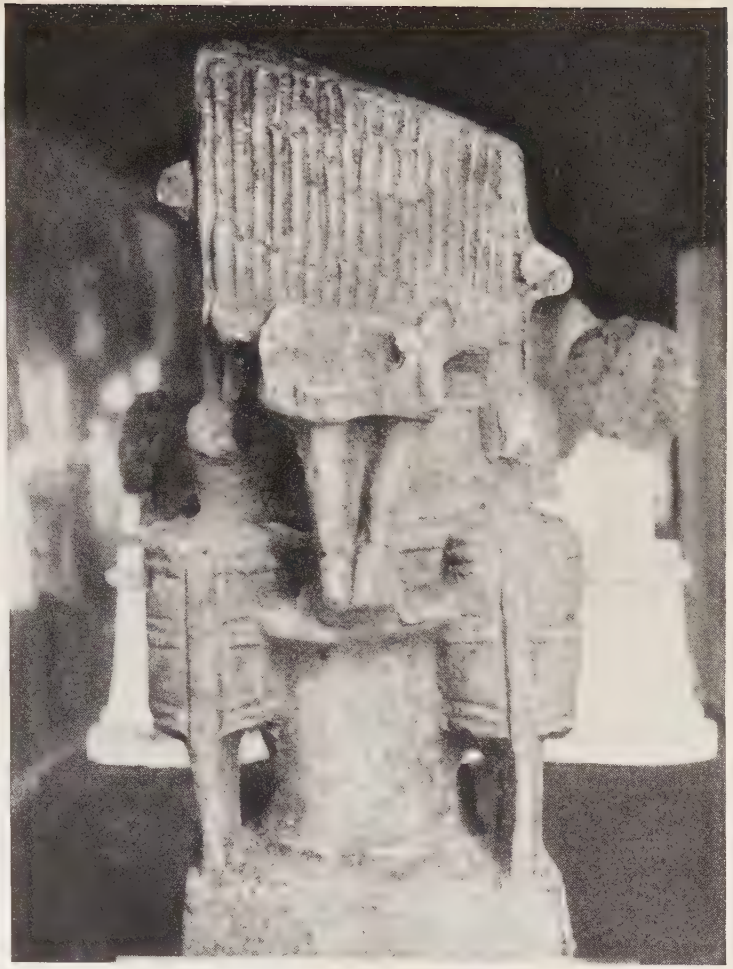
THE BASILICA OF SAINT CYPRIAN (SEE TEXT, PAGE 409)

View to northeast, with the red hill on which Sidi-bou-Saïd rests, like a white dove, to the left. This large church, dating from the fourth or fifth century, was surrounded by graves, from whose inscriptions much has been learned about the history of Carthage after the Roman occupation. The boy with his cattle is a fair type of the children who roam over the site of the old city and live in cisterns, mud hovels, and pits (see page 395).

Photographs by Maynard Owen Williams

VICTORY (LEFT), FOUND IN 1894 ON THE BYRSA, AND ABUNDANCE (RIGHT), RECONSTRUCTED FROM 250 FRAGMENTS

The sculptures are Roman. On the small column pedestal under the portico to the right of Abundance is a small statue of Æsculapius and the little god Telesphore. This small statue illustrates the perplexities and joys of the archeologist. Several years after the body of the statue was found Père Delattre was conducting a professor from Algiers around the Necropolis on the hill of Saint Monica, probably a mile away from the Byrsa, where the body was found. His workmen were just then unearthing a marble head. The savant at once suggested that it seemed to belong to the body found years before. The whole party started for the museum, hoping to see the reunion of torso and head, but when the two were brought into close relation it seemed that the head was too large for the body. Père Delattre then fitted the head on to the body, and so perfect was the union that one could scarcely see the point of junction. A part of the arm was found at the same time and in the same place.



Photograph from Byron de Prorok

REPLICA OF AN ORGAN DATING FROM 100 A. D., DISCOVERED BY PÈRE DELATTRE

This is one of the most remarkable pieces of statuary unearthed at Carthage. Note the feet of the musician and the organ bellows to the right and left.

Photograph by Maynard Owen Williams

THE PRIESTESS ARISATBAAL, THE FINEST EXAMPLE OF PUNIC ART EXTANT

This statue is the cover of the marble sarcophagus seen below it, in which there are still the remains of this lovely woman of the days when Tanit and Baal were worshiped (see page 400).

Photograph from Byron de Prorok

AN EXAMPLE OF MOSAIC FLOOR FOUND IN TUNISIA BY THE SERVICE DES ANTIQUITÉS
(SEE ALSO PAGE 397)

their own mothers. This work of excavation is now in progress.

The altars unearthed at the lowest level were undoubtedly of Egyptian origin. Rectangular silver tablets engraved with squatting sphinxes, and amulets of bluish stone representing the eye of Osiris and covered with Egyptian hieroglyphics conclusively demonstrated the one-time influence and probable presence of that race. There is ground for the belief that Baal Ammon was originally the Ammon Ra of the Egyptians.

New light may be shed on the mysterious rites of the early Carthaginians, as the excavations proceed. The votive tablets we have discovered are invariably inscribed in the following form: "To the divinity Tanit, Face of Baal, and to the Lord Baal Ammon, a votive offering

Photograph by J. Deconcloit

THE SITE OF ONE OF THE OLD VILLAS OVERLOOKING THE SEA BELOW SIDI-BOU-SAÏD

In the distance looms the crescent peak of Bou-Kornein (see also page 399).

Photograph by Maynard Owen Williams

DRAWINGS ON OSTRICH SHELLS FOUND IN CARTHAGE

Photograph from Byron de Prorok

AN URN CONTAINING BONES OF CHILDREN SACRIFICED TO TANIT AND MOLOCH

This grim reminder of the practice of human sacrifice by the Carthaginians was discovered in the Temple of Tanit last year (see text, pages 400 and 402).

made by Hasdrubal, son of Hanno, because he has heard the voice of the goddess, blessed be she."

BABIES SACRIFICED WHEN THE CITY WAS IN DANGER

The shocking ceremony of human sacrifice was especially resorted to when Carthage was in great danger from her enemies. Hundreds of children of the noblest families were offered up to placate the rage of the hideous god Baal, whose horned and bull-headed image stood in the temple in constant readiness to receive his living food. The arms of the idol were raised by pulleys, and amid the clashing of cymbals, the beating of drums, and a fanfare of musical instruments the sacrifices were dropped into the burning interior.

Fascinating results of a different character were found in our excavations north of the Acropolis on the Hill of Juno. Above the surface of poppy fields appeared a mound of bricks, and setting to work we disclosed the roof of a Roman palace; then seven perfect mosaic floors of the first Roman period (see pages 397 and 406).

There were hundreds of broken stones bearing inscriptions, fragments of statues, and a complete collection of African lamps of the period from 100 to 300 A. D.

Of especial significance was the discovery beneath the mosaic floors of a Punic ruin, which led us thirty yards under the hillside and established beyond any dispute that the Carthage of old had not been totally obliterated.

Some of the ruins on the Hill of Juno are very probably the remains of the famous baths of Gargilius, where the council of 565 bishops met in 411 A. D. to determine whether Christianity was to remain Catholic or become Donatist. In a vaulted chamber near by, which might have been the boudoir of a Carthaginian lady, were found perfume bottles, bracelets of gold, ivory hairpins, bronze mirrors, nail scissors, ivory eyebrow sticks,

and much iridescent glass (see page 413).

In the Roman cisterns were revealed new wonders; an early Christian basilica with the tombs of martyrs and Christian inscriptions, many fine Byzantine relics, and seven statuettes of the Virgin Mary in terra cotta were also revealed. As in the case of many of the chapels, this had doubtless been built in secrecy to escape the persecutions of the second century.

Twelve basilicas have been located, all told, though only three have thus far been properly excavated. The basilicas of St. Cyprian (see page 400) and Damous el-Karita (page 410) are two of the purest examples of Christian sanctuaries known.

Hundreds of tombs of martyrs lie between our former headquarters and the amphitheater to the north of the city (see page 401). An inspection of the coffins frequently revealed three nails, indicating that the victim had been crucified.

Photograph by Maynard Owen Williams

THE TEMPLE OF TANIT

It was in this temple, recently discovered by an amateur archeologist, that Carthaginians offered human sacrifices to the goddess Tanit and to Baal Ammon (see text, page 400).

ROUGE POTS, SPECTACLES, BRONZE RAZORS, AND BABIES' MILK BOTTLES FOUND

On the heights of Cape Carthage have been excavated by the Service des Antiquités ancient Punic tombs which had escaped the Roman conflagration, and these were buried, in many cases, thirty feet in solid rock. Mummies were found, beside which the personal adornments had been placed, jewels and trinkets in variety, inscriptions and sacred images, while at the entrance to the tombs grinning masks had been placed to frighten away evil spirits.

In four months we found 5,000 coins in gold, silver, and bronze and Roman remains, including also pottery, frescoes, bracelets, jewels, rings, and lamps. Vandal armor and strange lamps of barbaric shape recalled the inroads of the merciless followers of Genseric and Hunneric. The Museum of Carthage will rival in interest, it is believed, any of the world's great repositories for relics of the ancients. A pair of spectacles of the third century B. C., found in a Punic tomb, a terra-cotta figurine of an organ (page 405), pots of rouge and face powder, bronze

FAMOUS EL-KARITA, ONE OF THE MOST IMPORTANT DISCOVERIES OF PÈRE DELATTRE, THE LARGEST BASILICA THUS FAR UNEARTHED AT CARTHAGE

It was here that Père Delattre found 14,000 pieces of inscriptions from the tombs of the early Christians. A great many of these he has reconstructed, the most famous being those of the two patron saints of Carthage, Saint Perpetua and Saint Felicitas (see page 423).

razors and milk bottles (see page 413), found in the tombs of Carthaginian children, are also museum results of the researches of the great dean of French archeologists, Père Delattre.

Our historical, topographical, and archeological search indicates that the old Punic city did not occupy the site of Roman Carthage. On examination of the ground near Cape Kamart and the Sokra marshes I discovered traces which may lead to an impressive discovery, especially in the revelation of six ancient towers, which seem to have served as watch towers or lighthouses for the port. Strangely, these all apparently faced inward, toward the marshes, rather than seaward.

It may be surmised, however, that the towers, which are fifteen feet in diameter, may have served the double purpose of lighthouses and beacons by which the ships might find their respective moorings at night. Below their outlines I discovered the remains of a great wall, traceable intermittently for a mile and a half. It indicated a width of not less than fifteen feet, and continued examination may prove that it formed a part of

Photograph by Soler, Tunis

ENTRANCE TO THE LAVIGERIE MUSEUM

This trunk of a horse is considered one of the best bits in the garden of the White Fathers.

Photograph by Soler, Tunis

THE ROMAN THEATER AT CARTHAGE

This photograph was taken soon after excavation. Now the columns have been covered over or removed. In this great ruin the representation of Shakespeare's "Julius Cæsar" will be given for the first time in North Africa, on the anniversary of the poet's birth, this month (April 23, 1924). The performance has been arranged by Countess de Prorok, formerly Miss Alice Kenny, of New York. It will be followed by a visit of the Comédie Française, which will give a series of representations this spring—plays of Molière and Racine, especially the latter's "Britannicus" and "Andromaque." In the background is Bou-Korneïn (see text, page 391).

Photograph by Soler, Tunis

IN THE MUSEUM OF CARTHAGE

Top, from left to right: (Case A) Surgical implements, razors, and Carthaginian ladies' bronze mirrors, some beautifully engraved, and iron clamps which held together the stones of the temples; (Case B) Roman, Carthaginian, Vandal, and Byzantine arms and scissors and rings used by the Carthaginian ladies; (Case C) Collection of beautiful bronze mirrors; (Case D) amphoræ (vases); (Case E) incense-burners from Carthaginian tombs, and a collection of Carthaginian, Roman, Byzantine, Vandal, Arab, Greek, and early Christian lamps; (Case F) babies' milk bottles.

the quays and landing stages of the great ports. It is of very ancient and massive construction.

Other interesting remains in the neighborhood were a succession of deeply sunken wells formed by huge masses of hewn rock. These were at a depth of fifty feet, and, upon descending into several of them, I observed that the slightly moving waters hinted at the existence of an underground stream. The wells are not marked on any of the published maps of the peninsula, where the shifting sands have covered up so generally the traces of the Punic city. Roman Carthage possessed no fresh-water wells—a fact which necessitated the construction, at vast expense, of one of the greatest aqueducts ever built by the Romans.

That the conquerors of the Carthaginians should have selected a slightly different location for rebuilding is suggested strongly by Scipio's interdiction: "Cursed are they, and doubly cursed are they who try to resurrect them." Another clew comes from Virgil in his description of Æneas' ascent of the hill which overhung the city, "whence he could see the opposite towers," and where, as Dryden translates him,

"The gates and streets; and hears from every part
The noise and busy concourse of the mart."

The location here indicated is plainly the hillside of Cape Kamart, which rose directly from the walls and ports. It would not have been possible to look down upon the town from any other part of the peninsula. The hill of Sidi-bou-Saïd (see page 395) is for many reasons not to be considered that to which Virgil referred.

SUBMARINE RUINS PHOTOGRAPHED FROM AN AIRPLANE

The first attempt to photograph submarine ruins was recently made by the late Prince de Walbeck, who was killed last June on his way back from Carthage. His airplane photographs are a unique documentation in archeology, and are superior to any observations which could have been made at the surface of the water. They bring to view constructions submerged thirty feet at a distance of one hundred yards from shore.

The pictures were taken at a height of 1,000 feet, and also at 400 feet, following the line of the ancient wall. One is able to study the topography of the peninsula to excellent advantage. The bed of the Medjerda is clearly visible and the wall of Theodosius can be partly seen. Even the Roman allotments are defined.

This airplane photography established the fact that there had been a port at La Marsa (the Arabic el Mersa means a port). The construction perceived under water is of vast dimensions and zigzags from Cape Carthage northeast to Cape Kamart.

GREEK ART TO BE RECOVERED FROM A SUNKEN GALLEY

Off the coast of Mahdia, more than a hundred miles south of Carthage, was observed by airplane a sunken galley 120 feet below the surface of the water, the existence of which had been known to sponge divers. I have obtained the consent of the Service des Antiquités to continue the work of recovering from the galley the specimens of Greek art, some of which were removed prior to the war.

In the Bardo Museum of Tunis have already been placed magnificent marbles and bronzes taken from the treasure ship, where they had reposed since 100 B. C., and not 500 A. D., as stated in certain works of reference.

The Gulf of Tunis has been further explored by us in recent months in the expectation of locating some of the 500 ships which met their fate during the Punic wars. One of Genseric's booty ships is known to have sunk in the gulf after the Vandals sacked Rome in 453 A. D. In the continuance of this work the airplane will play an important part.

Further evidence that Punic Carthage did not lie beneath Roman Carthage was recently afforded by a discovery on the part of Père Delattre northwest of the Hill of Bordj el-Djedid (see map, page 394), where a large quantity of Punic incense burners of about 400 B. C. were unearthed (see page 413). This is two miles from the site commonly considered by historians. The only Punic statue found thus far (see page 405) is likewise accredited to Père Delattre, and that was beneath the garden of the Lavigerie

THE POET RECITES HIS LAY

The entertainer, being blind, is admitted to the sacred precincts of this Tunisian home. During childhood the little daughters of Tunis wander at will through the vivid throngs of the city, but at thirteen they assume the Mohammedan veil of femininity, and henceforth their activities are much restricted.

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Autochromes by Gervais Courtellemont

CHILDREN OF THE OASIS OF TOZEUR

Tozeur, an oasis lying 300 miles to the south of Tunis, is notable for the richness and variety of its vegetation. The dates of this and other Tunisian oases are famous the world over.

©

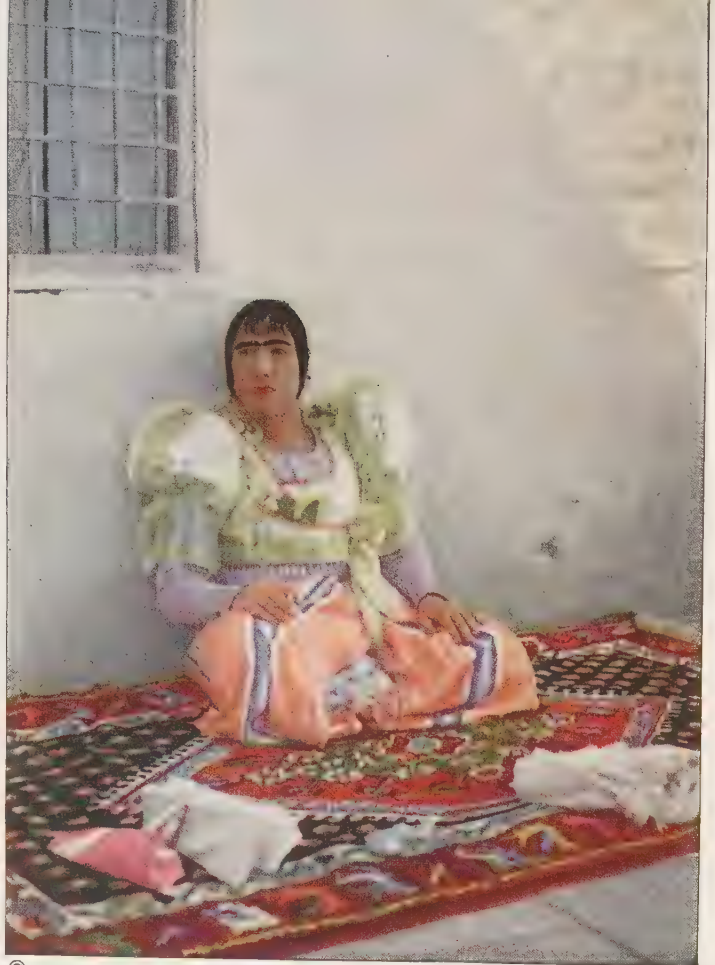
A POTTERY MERCHANT WAITING FOR CUSTOMERS

The glare of the African sun is shut out of the business district of Tunis by vaulted roofs, and the shopkeepers laze before the windowless recesses in the walls which constitute their stores. The Tunisians have manufactured pottery for centuries—a kind of majolica in green and yellow and a reddish, sun-baked ware ornamented with conventional designs.

Autochromes by Gervais Courtellemont

TUNISIAN WOMEN AT HOME

Upper-class Mohammedan women of Tunisia are seldom seen on the streets; when women of the middle class walk abroad they wear veils of jet-black crepe, and in addition hang before their faces curtainlike pieces of richly patterned silk, which make it impossible to see more than a few feet to the front.



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A FAVORED DAUGHTER OF THE HAREM

Neither Jew nor Mohammedan in Tunisia is supposed to see his bride before marriage. She may be chosen by his mother, according to her own tastes, or she may be selected by his father to advance his business interests. Sometimes he is put down for marriage as soon as he is born. Both Jewish and Arab women retain full rights over their personal estates after marriage, however.

Autochromes by Gervais Courtellemont

DRYING WHEAT AFTER IT HAS BEEN WASHED

Wheat is the chief cereal grown in Tunisia, but the system of agriculture is primitive. Most of the farmers clear their land or do their plowing with crooked sticks. Perhaps the most successful branch of agriculture is grape-growing, for the vine seems to thrive in the sun-baked soil, and some eleven million gallons of wine are produced annually.

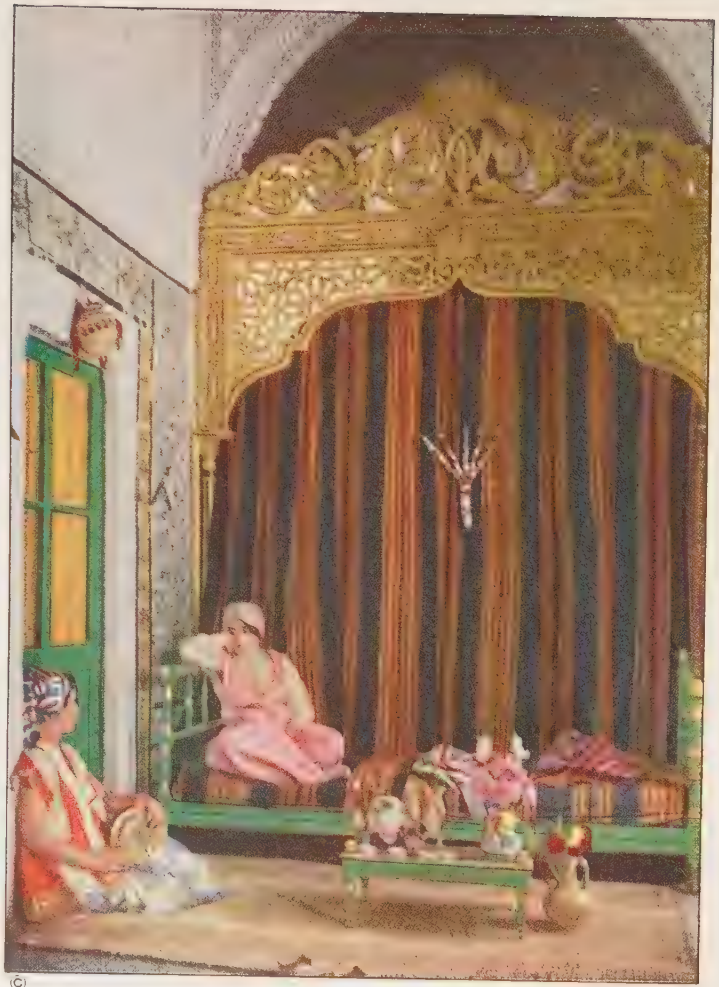
© Autochromes by Gervais Courtellemont

THE SOUKS, OR COVERED SHOPS, OF TUNIS

Each craft in Tunis has its own street, and the best guide through the mazes of this covered world is one's nose, as the city is notorious for its smells. From some of the provinces of Tunisia many aromatic herbs and fragrant flowers come to tempt the perfumer to the perfection of his art in the Souk el Attarine, or Street of Perfumes.

THE HAT AND LEATHER SHOP OF A TUNISIAN MERCHANT

Saddlery and leather embroidery are two of the most important industries of this part of northern Africa. The craftsmen turn out gorgeous high-backed crimson saddles with mountings in brass to catch the fancy of the expert horseman, and fascinating bags, cardcases, belts, and rug-straps to please the impressionable tourist.



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THE CANOPIED BED OF A TUNISIAN INTERIOR

A DESERT BEAUTY

TELLING THE FAMILY'S FORTUNE: TUNIS

© Autochromes by Gervais Courtellemont

A STREET IN A NATIVE QUARTER OF TUNIS

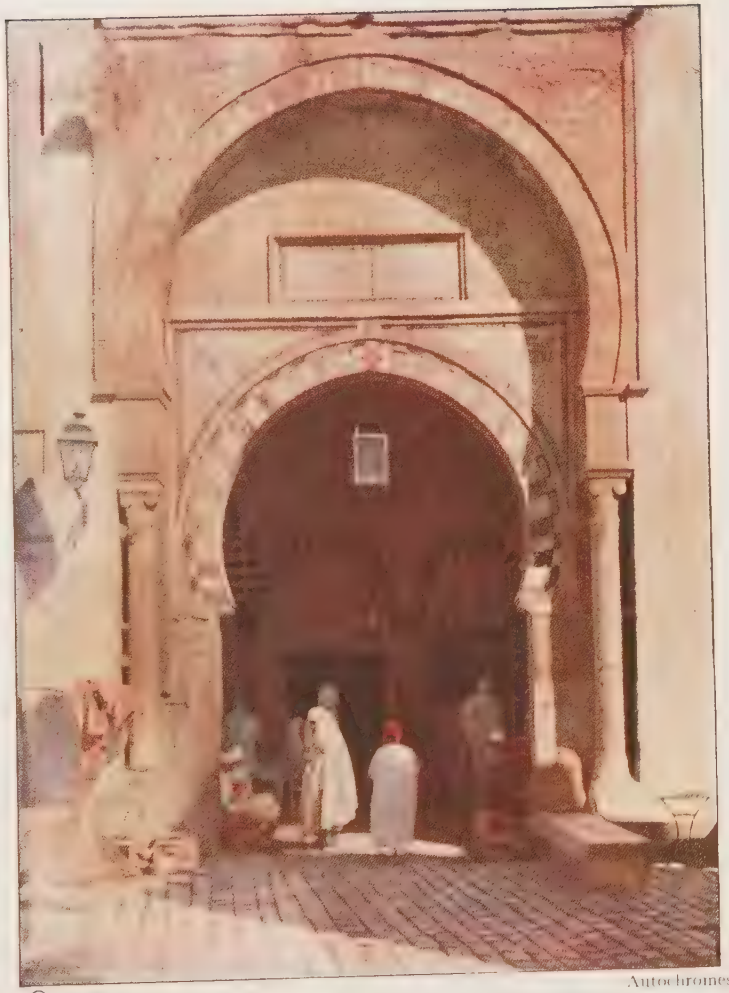
Many countries have contributed to the population of "The White Mantle of the Prophet," as the Arabs call this city. It has become the racial melting pot of the Mediterranean. Standing at the gateway to the "New World of France and the Old World of the desert," Tunis lies at the threshold of the archeologist's treasure house—Carthage (see page 391).

A BEDOUIN GIRL OF SOUTHERN TUNISIA

© Autochromes by Gervais Courtellemont

A JEWISH FAMILY OF TUNIS

Among the 200,000 people in the capital of Tunisia the Jews are exceeded in numerical strength only by the Mohammedans and the Italians. In fact, Tunis was mentioned at one time as an ideal place for the establishment of the new Jerusalem. Obesity is considered a mark of great beauty among Jewish women of Tunisia.



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THE CITY DOOR OF SUSA, ON THE TUNISIAN COAST

A TUNISIAN COUNTRY WOMAN

Autochromes by Gervais Courtellemont

building at La Marsa, three and one-half miles from the Carthage of to-day.

No land has more wondrous or more beautiful Christian ruins than North Africa. From Shershel, in Algeria, to Carthage, in Tunisia, the pilgrim follows the sacred way of the routes of the basilicas, where every step treads on holy ground, sacred to the blood of saints and martyrs.

OLDEST REMAINS OF CHRISTIAN EDIFICES

Few, indeed, know the importance of the African ruins, which are the oldest remains of Christian edifices in the world!

If one wishes to see what the first Christian churches were like, it is not to Rome one should go, but to Africa. They do not exist any more in Rome, for they have all been destroyed or built over; but at Carthage and Tebessa one can still see the largest basilicas in the world and easily imagine what they were in the days of St. Augustine.

Two hundred and fifty basilicas, churches, and chapels have been discovered and partly explored; thousands of Christian inscriptions, tombs, and relics laid bare, and yet there has never been a pilgrimage to these sacred and beautiful ruins.

Some of the most wonderful catacombs and cemeteries of the first centuries of Christianity are to be found at Susa (Sousse) and at Tipasa the deserted, with its basilica dedicated to St. Salsa, one of the most celebrated African martyrs; Tebessa, the largest early Christian ruin on earth, so reminiscent of the day of St. Augustine; Souk Ahras, the home of that saint; Hippo, where only a few stones and the name of one good man remain; and then to Carthage, where the great St. Louis of France died and where the glorious martyrs, St. Cyprian, St. Perpetua, and St. Felicitas suffered for the Christian faith (see page 401).

Carthage, too, is sacred to the memory of St. Vincent de Paul and of Tertullian. Pope Leo IX said: "There is no possible doubt that the bishop of Carthage is the greatest after Rome and the greatest metropolitan of Africa."

MYSTERY STILL VEILS PUNIC CARTHAGE

It is still evident that only profound investigation can pierce the veil of mystery which shrouds the site of the great Phœnician city. The most painstaking search through the Peninsula of Carthage is required to substantiate finally all of the new theories which have been developed of late.

My own explorations convince me beyond all doubt as to the error which has persisted for centuries regarding the location, and such progress as I have been fortunate in making is due to a few records of ancient historians, the Arab documentation of the Middle Ages, a study of geographical changes, and the excavations of the last five years.

Through all the desolation of the surroundings and amid the débris that blankets the entire peninsula, the voices of Hannibal, Scipio, St. Augustine, St. Louis, St. Cyprian, and other mighty spirits seem to summon the modern world to the task of discovery and enlightenment.

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This notice to the members is necessary, unfortunately, because of the fraudulent operations of unauthorized persons claiming official connection with The Society or the Magazine.

All membership fees should be made payable to the National Geographic Society.

Photograph by J. Truyol é hijo

THE NATURAL HARBOR OF SÓLLER, ON THE ISLAND OF MAJORCA

Crowning the distant promontory is one of the medieval towers from which the islanders kept watch against Moorish pirates (see text, page 431).

KEEPING HOUSE IN MAJORCA

By Phoebe Binney Harnden

"CEYLON is only forty miles from heaven," said the enthusiast, as we sat on the deck of a steamer bound for the Far East. It was then that the uncommunicative man, who had lived there, looked up and quietly asked, "Why the forty miles?"

That was the way we felt about Majorca after our first trip—and in fact have felt so ever since.

Why the Balearic Islands should be so little known to the modern tourist is a mystery, albeit a pleasant one. Even in the times of the Bible, the strength and valor of the "Balearic slinger" were well known; and before that the wild bravery of the Majorcan seems to have been worthy of comment. Fortunately, his warlike character seems to have evaporated with time, leaving a country whose tranquillity is untouched either by modern hurry and bustle or the equally hurrying and bustling modern tourist.

It is my instinct to keep it all as secret as possible. When Palma, the capital, called, and rightly so, by the ancients "The Pearl of the Mediterranean," is within overnight distance from Barcelona and but little more from Marseille, it would be painfully easy to overrun the place and so spoil this seemingly unique spot.

We discovered it quite by chance ourselves. With the help of guidebooks, we had been traveling in fancy all over Europe searching for just such a spot. Then a friend assured us the only place to go was Majorca. In our attempt to look well-informed we evidently only attained blankness of expression, for enlightening explanations hastily followed. Mary Stuart Boyd's book, "The Fortunate Isles," was given us for our edification, and from that time we began our career of enthusiasm for Majorca, the largest and most beautiful of the Balearic group.

Mrs. Boyd had a house in Deyá, one of the small villages of about 800 inhabitants (see map, page 431), where she said we might go. It had once been the wing of an old monastery, and though we were warned of rough simplicity, off we started, bag, baggage, and baby.

It worried us not at all that none of us spoke a word of Spanish, and it worried us less when we saw our little stone house, overlooking the blue waters of the Mediterranean, with its olive terraces leading to pine-covered bluffs beyond.

What did it matter if the trip to our daily swim was half a mile down and a seeming five miles back? The clear warm water, surrounded by adventurous-looking rocks and caves, made the best swimming we had ever experienced; and then the terraces, with their twisted olive trees, planted by the Moors over a thousand years ago, looked like a Rackham illustration for "Peter Pan." Figs and oranges we might pick freely with no thought of irate owners.

In the little rose- and honeysuckle-filled garden, with its flagstone paths covered by a grape arbor, we used to sit and have our meals from a great stone table where the monks ground their corn. That garden alone seemed compensation enough for the whole journey, to say nothing of the cold, clear spring around which was the rough bench where the monks were wont to sit for rest and recreation.

THE FAMILY DECIDES TO OWN ITS MAJORCAN MANSION

It mattered little, too, if the door, whose thickness and great iron bars might keep out any reasonably sized enemy, could not keep out the wind, nor in fact the dog, so great was the—shall I call it lack of precision of door jambs? The weather was balmy and it was not until the rains set in that we thought of moving to our new house. We had not been in Deyá de Majorca a week, however, when we decided, with a unanimity one strives for and seldom achieves in family circles, that here we must have a house of our own.

We began housekeeping with difficulties.

With what glee did we work out Spanish sentences constructed from dictionary and phrase book, planning literally to astonish the natives; and with what sinking

Photograph by L. Melano Rossi

A GENERAL VIEW OF PALMA, ISLAND OF MAJORCA, CAPITAL OF THE BALEARIC ARCHIPELAGO

The Carthaginians were the first civilized people to settle in the Balearic Islands. Shortly after the destruction of Carthage (see page 391), the Romans accused the islanders of piracy, sent Metellus to subjugate them, and established a colony of 3,000 Romans and Spaniards, who founded the city of Palma. The imposing building to the right is the cathedral, begun in 1230 by James I (Jaime).

hearts did we watch the puzzled expressions with which they were received! It was only after our sentences had been met with a blank stare that we learned that many, probably the majority, of the inhabitants speak only Majorcan, a dialect impossible for a mere Spanish student to understand.

Those first days the local doctor was a busier man than he had been for many moons. He spoke a little French. At least twice a day he was hastily sent for, and most courteously, and incidentally gratuitously, came, though it was a mile from his home, in order that we might tell him in our very bad French that it was impossible for us to drink goat's milk, and request him to inform the servant of the fact; or that we would like fresh rolls every morning by the *diligencia*.

TRIALS WITH LAMPS

The one amenity of life that we had been promised was acetylene gas made for our own lamps. Whether it was because we were particularly uncongenial with the amenities, I cannot tell; but I do know that we never achieved the acetylene gas. There was invariably a flare that made everyone apprehensive while it lasted—which was never more than a few minutes, however—followed almost immediately by a pinpoint of light that we came to call "yon illuminat," but which did not illuminate enough even to make darkness visible.

The natives all use the picturesque, small, open, oil-burning lamps, like those of the early Christians, that have become associated in our minds with museums and catacombs. We even tried those; there is nothing like surrounding one's self with "local color." But they literally smoked us out of house and home, and we finally resorted to the common home-grown lamps and candles.

What we would have done those first weeks without the unfailing courtesy and patience of our fast-forming circle of friends and neighbors I do not know.

All our marketing had to be done by signs. And what contortions we went through! Eggs were, for instance, a comparatively easy order. One can always indicate the shape of an egg with

Photograph from Ernest Peterffy

ALONG THE NORTHWEST COAST OF MAJORCA

In the foreground is the park and country-house of Miramar, estate of former Archduke Ludwig Salvator of Austria, who used to spend his summers on the island and who wrote a voluminous work on Majorca and the Balearic Islands (see text, page 431). At the left, in the sea, is the *roca perforada* (perforated rock).

Photograph by J. Truyol é hijo

THE CLOISTERS OF THE CHURCH OF SAN FRANCISCO IN PALMA

This beautiful thirteenth century building, rivaling the cathedral in antiquity, is the resting place of one of the most famous medieval heroes of the Balearic Islands—Ramón Lull, variously and successively described as a rake, a recluse, a scholar, a fanatic, and a saint.

the fingers, and while to cackle like a hen may not be dignified, at least it is effective for making one's self understood. Fruit was more difficult.

The little village store was the meeting place for the men. Everyone would leave his card game or glass of aniseed and gather respectfully in a circle while we made our signs and motions. Then a brilliant idea would occur to one, a hasty conference would ensue, and perhaps an onion would be brought out when we were signaling for apples; but in the end we always seemed to be understood, for all entered into the game with the same zest that we displayed.

In fact, we soon began to fancy ourselves exceptional linguists. One hot afternoon I remember that the boy of the party, as he sat out on the stone table under the arbor, made strenuous conversation with some peasant women. I say "strenuous" with reason. Such a running in and out—now for a dictionary or phrase book, now for a piece of string or some other "property," and during the interims wild gesticulations. Occasionally the performer was greeted with peals of laughter.

Photograph from Ernest Peterffy

ENTRANCE TO A DWELLING IN A MAJORCAN VILLAGE

Finally my curiosity became greater than my desire for a siesta. I went out to discover the cause of the disturbance. "Well," the boy explained (and this despite the fact that scarcely any one has been to school; so reading and writing are dead subjects, let alone geography), "you see, I am just explaining to these people about the Equator." And he was equipped with all of two weeks' knowledge of Spanish!

But he was not to be discouraged. Within a few days of his teaching experience the boy went to Sóller. With pride he related how he had ordered four meat pies to be sent the next day by the diligencia. We all agreed that that was quite a remarkable feat. He explained at length just how it could be done.

Next day the diligencia stopped at the foot of the hill, but when Angela, the servant, came struggling up the path, laden with two huge tin boxes, we were surprised and later dismayed to find that twenty-two meat pies had arrived.

For days we fed meat pies to the family, the servant, all her friends and relations, and finally the pigs. However, we could not gainsay the fact that the boy

Photograph from Ernest Peterffy

THE LIGHTHOUSE AND PORT OF PALMA

In the distance is the bathing resort of El Terreno and on the hill stands the old royal castle Bellver, still well preserved after nearly seven centuries.

had ordered meat pies, and that they had arrived. The slight mistake as to number was a negligible factor.

EVERYBODY SHAVES ON SATURDAY NIGHT

On our first Sunday in Majorca we were surprised and not a little mystified at the apparent change in the character of the male population. We had arrived toward the end of the week, and a more murderous-looking set of individuals it would be hard to imagine. But on this day, when we went to the village, everyone seemed suddenly to have acquired benign characteristics. Even the *carabineros,* as they started out to guard the coast against smugglers, in spite of their dramatic costumes, with rifles over their shoulders, looked the simple, kindly fathers of families that they are.

Then we discovered the cause. Saturday night the entire male population is shaved, almost *en masse,* at the barber shop. It is curious how dark, heavy beards will alter an expression.

The barber incidentally is the leader of the band, the bootmaker, and the veterinary for the village. I remember that some time later the dance of the year was delayed because the musician's services were required at our house to attend our goat, which had chosen that inconvenient time to become violently ill. But the delay was nothing; the festivities continued with due ceremony later.

Such dances as they are! A platform is erected on one side of the open-air plaza, and there, under decorations of real flowers and incongruous gaudy tissue paper, the band sits in state.

The band, by the way, is composed of everyone who can blow a trumpet or beat a drum, ranging in age from seven to seventy, and in occupation from the road-mender to the *alcalde* (mayor).

Around the plaza, on improvised benches and kitchen chairs, sit the populace in their "best," under more paper decorations and many lanterns. The priests have disapproved of round dancing, but the native dances are not under the ban, and as these are so much more wildly picturesque than any of the modern variations, nothing is lost by the edict.

The plaza is the only flat space in the village, which is built on the steep side of the ravine, beside a gurgling stream. In addition to the old defense towers and ancient ruins of a castle on the side of a mountain, the village itself strongly reflects the influence of the Moors, who were driven out in 1232—quite a modern time in Majorca. There are still paintings on the houses done by the Moors before their spectacular exit, when they were conquered by James I (Jaime) of Aragon.

A historical beauty spot of the island is one of the two mammoth caves where 800 Moorish refugees, with their household belongings and herds, lived for two weeks while besieged by the Spaniards.

In the blackness of this cave one can imagine the weird shadows cast against the cathedral-like rocks by the torches of these refugees; for, unlike the cavern at Manacor, with its underground lakes and varicolored stalactites, this is somber and of uniform black and white.

The most lasting reminders of the Moorish menace are old defense towers, built to warn and protect the Majorcans from the piratical raids that seem to have been the chief sport of the Moors after their eviction. These still stand firmly in their commanding positions (see p. 424).

Our present house is built with one of the old towers as a starting point. Although the loopholes through the four-foot walls no longer serve as casements for bowmen, they are of great convenience as shelves for tooth paste and such articles.

The lookout tower is unnecessary when it comes to warning the countryside, nor is it particularly useful for pouring boiling oil on offending heads that come to besiege it; but a more charming sleeping porch would be hard to imagine, with its view of a semicircle of vividly colored mountains on one side and a deep gorge leading to the Mediterranean on the other.

The World War touched Majorca only slightly, although the natives complained even there of high prices. Sometimes I had to pay as much as four cents for a great plate of figs or tomatoes, where two cents would have served before! But, as we had so many gifts of fruit and vegetables in any case, the price somehow did not seem exorbitant.

Drawn by Charles E. Riddiford

A SKETCH MAP OF MAJORCA, BALEARIC ISLANDS

The German submarines profited by the prices and came often for supplies. We saw two from the balcony of our house during the first of our Majorca stays.

WHEN AN ARCHDUKE EARNED TWO CENTS

Some of the pro-German sentiment here was probably directly traceable to the former Archduke of Austria, who had something like eight big houses and owned the greater portion of the most beautiful northern part of the island, where pine-covered bluffs tumble with great spectacular cliffs into the sea (see page 427). It is difficult to imagine how he obtained the land. In that part of the island it is almost impossible to buy even a square foot of ground, for every plot is handed down from generation to generation and rented out in small holdings. At the Archduke's death his estate was inherited by the children of his secretary, a native of Deyá, so that the land has once more come back to its own.

The Archduke seems to have been a very genial individual; he was certainly

Photograph from Phœbe Binney Harnden

A MAJORCAN GIRL WITH NATIVE POTTERY

Photograph by L. Melano Rossi

INNKEEPERS AT POLLENSA— THE LANDLADY AND THE MAID

Photograph from Phœbe Binney Harnden

DRAWING WATER IN POLLENSA, A VILLAGE NEAR SÓLLER

Photograph by L. Melano Rossi

GENIAL MAJORCANS

A TARTANA, THE FASHIONABLE CONVEYANCE OF MAJORCA

Photographs by L. Melano Rossi

PIGS OF POLLENSA, RAISED FOR EXPORT TO BARCELONA

Cold storage is unknown in Palma. One writer declares that sheep and oxen are "killed, cut up, and sold almost before they have had time to cool."

Photograph by L. Melano Rossi

SUNDAY MORNING, AFTER CHURCH, IN PALMA

Photograph from Ernest Peterffy

FISHERMEN OF THE BALEARIC ISLANDS

These Majorcans live at Valldemosa, near Palma, in the shadow of a once famous Carthusian convent, in a cell of which the novelist George Sand lived during her sojourn on the islands.

Photograph from Herford Tynes Cowling

OLIVE TREES MORE THAN 1,000 YEARS OLD: MAJORCA

popular in Majorca, where they tell of his first trip to the islands when a young man. He was walking along the road when one of the peasants, now an old man in Deyá, had an accident with his loaded mulecart. The peasant called to the stranger and in none too careful language directed the Archduke's movements in aiding to repair the breakdown.

When the task was finished the obliging stranger was generously tendered ten *céntimos* (two cents), with the suggestion that he go get a drink. The Archduke thanked the peasant courteously, saying he would keep the coin as a memento, since it was the first money he had ever earned. The village still tells the joke and the peasant even now is made to feel embarrassed.

A SMUGGLERS' RENDEZVOUS

The supplying of the submarines was handled, so my neighbors told me, by a small society of men in Sóller (see page 424), about four miles northeast of Deyá. All the natural facilities aided them. For miles the coast is rocky, wild, and filled with caves—exactly the kind of caves for storybook smugglers.

The real smuggler still exists, though each night the carabineros, looking more like comic-opera figures than real-life guardians of the law, start for their all-night vigils along the coast. They are paid scandalously low wages, however, and the philosophical Majorcans shrug their shoulders and say, "What can you expect if they happen to fall asleep at convenient times and places, when the smuggler is free with gifts of money to his friends?"

Past our house goes a little donkey path to a cove on the sea, and sometimes in the dead of the night one can hear the tramp-tramp of many shod feet as they pass. Your neighbor will calmly tell you next morning that the *contrabandistas* were there in the night. On one occasion they probably needed rope, for they stole our donkey's reins; but, as some small, useful bit of cord is usually the extent of their iniquity, no one bothers them and they bother no one.

I have always longed to see them, for the winding path among the trees, with the background of wild, rugged mountains, is a setting for the smugglers, with their laden donkeys, upon which it would be hard to improve. But the nights are

Photograph by Dr. Franz Stoedtner

WINDMILLS ON THE ISLAND OF MAJORCA

During the summer there is often great scarcity of water on Majorca, but, thanks to a system of irrigation introduced by the Moors, the rains of autumn and winter are stored in reservoirs. In the dry reason the water is sold to landholders at a fixed rate. These windmills are in the olive oil district of the island.

dark and the shadows deep, and one can only hear—never see. I am told, however, that strenuous efforts are to be made against them, though when the boys bought contraband tobacco and then offered it to the carabineros for a smoke, no one seemed to think it anything more than an amusing incident.

The officers of the law are most diligent in prosecuting any other type of malefactor; but in Deyá crimes are few and far between. In 25 years only two people have occupied the little jail: one a man who came from another village and got drunk; and the other a woman of far from fair name, who thought she might, like Alexander, find new worlds to conquer. Word was sent ahead, warning Deyá of her arrival. A committee met her at the diligencia. She spent the night in jail and next morning was solemnly shipped back to Palma.

Recently a workman from another village stole a pair of shoes—and old shoes they were at that. The whole of Deyá was upset for two days; the unfortunate man was pursued for miles and finally caught.

Deyá is almost unconvincingly free from vice. There is practically no drunkenness. A diligencia driver and his family, who kept a wineshop, occasionally and unanimously got drunk on feast days; but they seemed to be the exception that proved the rule. Though there is no one very rich, there is no great poverty, and every one lends a helping hand to the families of the wandering carabineros, whose pay is small and, as is usual the world over, whose families are large.

Photograph by J. Truyol é hijo

THE HIGHROAD TO SÓLLER (SEE ALSO PAGE 424)

In the background is the Puig Mayor (pronounced pootch), the highest mountain on the island of Majorca, 4,740 feet. Soller, a town of 10,000 inhabitants, nestles in a valley surrounded by orange groves. Its chief industry is the manufacture of majolica, the pottery which is said to derive its name from the island.

There is no servant class. The girl who worked for us in that capacity for all of 20 cents a day was a relative of the alcalde. She treated us as her friends. She has helped us now a good many years, but always with that acknowledged status.

But no one needs servants in Deyá. Everyone is busy, though for the women the actual housework is simple. There are no carpets on the stone floors. The walls and ceilings are whitewashed and, incidentally, whitewashed often, for everything is scrupulously clean, though insanitary. Next to the well-scrubbed and whitewashed kitchen, there is the invariable pigsty.

THE KILLING OF THE PIG IS A BIG FAMILY EVENT

The pig plays a dual rôle in Majorcan villages. He is the general scavenger, and later can be killed and made into the red-and-black sausages that are hung on strings beside the dried tomatoes and peppers in the attic as a supply for the winter.

The killing of the family pig is one of the big events of the year. Although I have never quite come to the point of accepting the kind invitations of my friends to be there at the finish, the performance can be heard plainly enough to satisfy any bloodthirsty tendencies I might have. The relatives, family, and friends gather and all help to convert their erstwhile companion into such forms as are practical for winter food.

The meals are simple; for breakfast, coffee with bread and oil; luncheon, a variation of their many *sopas*, a dish of vegetables fried in oil, to which water is added, and finally the fluid soaked up with slices of their saltless brown bread; for supper, again sopa. Often there is sopa three times a day, accompanied by a dish of home-cured olives, small and rather bitter. The olive oil is of home production, made by primitive and picturesque methods. Under our house is one of the great olive presses, looking as though Brangwyn had drawn it to order.

The bread is baked in great community ovens. Olive branches are put in and burned until the oven is hot, then the coals are raked out, and after three prayers are said and the sign of the cross made, the bread and various fancy pies—rich bread crust covered with vegetables and slices of red sausage and sprinkled sugar—are put in.

Meals, when there is any regularity, are eaten in the low-ceilinged, whitewashed kitchens, in which there is usually built a second windowless inclosure with a low roof, where the family gather around an open pan of burning charcoal during the winter.

There are practically no wood-burning stoves; all the cooking and heating is done with open charcoal fires. To be sure, in our house we have a little oven built in next to the open burner, on the tiles. But, then, we are very modern.

We also have running hot water. Mention must be made of the fact, however, that all the water has to be carried up in *cántaros* and put into the *depósito* before it will run down. That is a mere detail. The entire village called the first two days we moved in, and each and every individual stolidly stuck his or her finger under the faucet to make doubly sure that it ran and that it was hot.

We also have the only piano in the village. When we brought it down the road, a circus procession could hardly have caused more commotion. The children sighted us first and passed the good word along; so that by the time it arrived at the house, there was a crowd waiting to help move it in, though only two were required.

There was hardly enough room on the case for the number of helping hands. Only when it was pushed down the narrow passage, and there was positively room for but one man, did any of them let go. I am afraid the piano, which every caller respectfully touched, and the running water were the chief causes of our excessive popularity in those early days.

PREPARATIONS FOR MARRIAGE BEGIN IN EARLY CHILDHOOD

Sunday is the great day for visiting; also it is the time for walking up and down the road in groups. The system of chaperonage is very strict. The girls never go out alone, nor after dark, and will frankly tell you that they must be very careful or they will never be married.

Photograph by Herford Tynes Cowling

A MAJORCAN COSTUME

A pigtail and the *rebozilla,* or head-handkerchief, are gradually disappearing at the instance of Majorcan girls who return to the island after a sojourn in France.

For that event they begin preparing in extreme youth. I have known a trousseau to consist of as many as a dozen dozens of everything. Imagine 144 night dresses, not to mention any of the other "unmentionables"!

The household linen is lovely. One may be sure of good sheets, nearly always embroidered or with open work, and a carefully made-over mattress, even in the little *fondas,* or boarding houses, where one pays 20 cents a day for a room (the board according to what you eat).

In Majorca it is an exceedingly bad housekeeper who does not have her mattress made over, whipped, and aired in the sun at least once a year.

Most of the work is done out of doors—raising vegetables, often on a bit of land some distance from the house, tending the orange or lemon crop, picking up olives, etc.

At sunset one does not wonder that this is called the Paradise for Painters, as the quaint figures, with their donkeys and goats, wend their way home from the day's work laden with bright-colored fruits and vegetables, or carrying great bundles of olive branches for fuel; the women wearing full, bright-red petticoats, which are always displayed to view, the outside skirts being drawn up around the hips for protection.

On the heads of the older women are silk handkerchiefs; on the younger sheer white caps as headdresses, the hair being worn in one long braid down the back.

THE FAMILY TURKEY IS TAKEN FOR A DAILY STROLL

Around Christmas time, to the family goat, donkey, and pig is added the family turkey. It seems to be the fashion to buy early, not so much to avoid the rush as to compare and show off this worldly possession.

In Palma, where there are real sidewalks, the family turkey is tied with a string to the front door, but at least once a day it is taken for a walk with the end of the string still tied to its leg. Sometimes it is carried, whether from fatigue of the bird or affection of the owner, I do not know. At any rate, the fortunate individual seems to get his money's worth from the turkey before it is led to slaughter.

Books could be written on Palma, Alcudia, and on Valldemosa, where George Sand and Chopin spent many happy days.

Despite George Sand's comment to the contrary, a more simple, kindly, frugal people would be hard to imagine.

At present, Deyá de Majorca is almost unbelievably ideal, as it lies surrounded by its rugged futurist-colored mountains, overlooking the blue of the Mediterranean. In these days of strenuous effort, it is a haven of tranquil beauty surrounded by people of kindly simplicity. And those who do not need the "madding crowd," can say, as said the uncommunicative man on board the boat for Ceylon, "Why the forty miles?"

SAKURAJIMA, JAPAN'S GREATEST VOLCANIC ERUPTION

A Convulsion of Nature Whose Ravages Were Minimized by Scientific Knowledge, Compared with the Terrors and Destruction of the Recent Tokyo Earthquake

By T. A. Jaggar

Director, Hawaiian Volcano Observatory

TWO of the greatest convulsions of the earth's surface in the history of mankind have occurred in Japan during the present generation.

The earthquake of last September destroyed 400,000 lives and wiped out billions of dollars' worth of property; the Sakurajima volcanic eruption of 1914 (the greatest in the annals of the Island Empire) resulted in the loss of only 35 lives and some millions of dollars in property.

Scientific investigation is, in large measure, to be credited with the relatively few casualties in the latter instance, for it was through the prediction of the imminence of the Sakurajima outbreak that the inhabitants of a populous district were enabled to flee from the wrath about to come. In Tokyo, on the other hand, the cataclysm of earthquake and succeeding flames caught the great Japanese metropolis of two million people and its adjacent seaport unawares and unprepared.

It was through a study of premonitory earthquakes in their relation to volcanic outbreaks that the Sakurajima eruption was definitely predicted; conversely, it is hoped that, in time, through exhaustive study of volcanic activities, earthquakes may be predicted with accuracy. If such forecasting can be achieved, it is conceivable that an earthquake of the severity of the Tokyo disturbance could occur with a loss of life and property almost negligible in comparison with what actually happened in September, 1923.

The phenomena of the Sakurajima eruption, therefore, are proving of transcendent importance to the scientific world, and the measures which were taken to safeguard life at that time are being eagerly studied anew.

The volcano of Sakurajima, shaped much like Vesuvius, rises to a height of 3,506 feet, directly opposite the city of Kagoshima, in Kagoshima Bay—a tongue of water extending some fifty miles into the southern end of Kyushu, the most southerly of the four main islands of the Japanese Archipelago (see page 449). Growths of young pine trees mark the course of old lava flows from the two main craters of the summit.

KAGOSHIMA'S FATE FORESEEN BY SCIENTISTS

Prior to the eruption of 1914, eighteen villages, with an aggregate population of 22,000 industrious farmers and fisherfolk, nestled on the shores of this small volcanic island, which nearly filled the bay between Kagoshima and the Osumi promontory. The channel between the volcano and the city was barely two and one-half miles wide, with a depth of from nineteen to seventy fathoms, while that on the Osumi side was only one-third of a mile wide, with an average depth of more than fifty fathoms.

Kagoshima, the thriving capital city of the province, with a population of 70,000, is the center of Satsuma pottery manufacture and of a fertile farming region, producing tobacco, citrus fruit, and sugar cane (see pages 450, 451, and 454).

Men of science had long known what lay in store for Kagoshima. Experience had taught observers that when "swarms" of earthquakes begin in the vicinity of an active volcano, the underground dragon is writhing and preparing to make trouble.

Photograph from T. A. Jaggar

THE BUSINESS SECTION OF TOKYO AFTER THE EARTHQUAKE

This photograph shows in the foreground, by the side of a canal crossing the city, the new shacks occupied by refugees, a go-down, or "safe-house," in the middle distance, and the Mitsukoshi department store (with turret). Most of the buildings that resisted the quake were gutted by fire. Thousands of parked automobiles contributed their gasoline to the flames. The property loss to the nation has been estimated at more than five billion dollars.

P. and A. Photograph

WHERE A TOKYO RAILROAD STATION ONCE STOOD: AMID THESE BLACKENED RUINS NEW BUILDINGS ARE ALREADY RISING

P. and A. Photograph

THE FIRST FIRE AFTER THE TOKYO SHOCK: METROPOLITAN POLICE HEADQUARTERS

In 1909 and 1910 two writers published warnings that Sakurajima was likely to erupt explosively after violent premonitory earthquakes.

For three years prior to 1914 volcanic eruptions had occurred in all parts of Japan, and Dr. F. Omori, the noted Japanese seismologist, was confident that a disaster of major proportions was impending. He planned an observation trip to Kirishima volcano, thirty miles north of Kagoshima.

The observatory at Kagoshima had recorded 91 earthquakes in 1913, as compared with an average of 34 quakes annually over a period of years. The greatest of the 1913 shocks occurred on June 30 and did some damage. Most of the disturbances were felt more strongly on the island of Sakurajima itself than in Kagoshima city.

At Yoshino, to the north of Kagoshima, springs suddenly ceased to flow in the autumn of 1913, and a pond and several wells in the city went dry. Yoshino proved to be exactly in the line of the fracture athwart the volcano to the east, where the eruption of the craters subsequently developed.

The rainfall during 1913 at Kagoshima had been unusually light, as had been the case ten years and twenty years previously, each of those dry years having been followed by some activity in one or more of the volcanoes on the island of Kyushu.

VIOLENT PREMONITORY ERUPTIONS BEGAN AT NEAR-BY VOLCANO

Violent eruptions began in 1913, not at Sakurajima, but on Kirishima, where there were three outbursts, the last two being on November 8 and December 9 (see illustration, page 455). Naturally, as January 9, 1914, approached, the inhabitants in the vicinity of Kirishima became extremely apprehensive; but that volcano remained ominously quiet.

On Sakurajima, however, earthquakes began to occur in "swarms" and people began to jump. Three strong shocks were felt on the afternoon of January 10, followed in the evening by two more. The next morning there were three strong shocks, accompanied by rumblings, before sunrise.

The earthquakes now became increasingly alarming. Growling noises pre-

ceded some and a roaring, as of escaping gas under pressure, followed others.

Ten strong shocks were counted during January 11, and scores of earthquakes were being registered by the seismograph at the meteorological observatory on the cliff west of Kagoshima—five shocks per hour during the morning, eleven per hour about noon, and some twenty per hour in the evening, with a maximum of twenty-eight between 8 and 9 p. m.

There was a lull in the quaking after midnight, but on January 12 twenty shocks per hour were felt from 3 to 11 a. m., at which time the eruption had relieved the stress and the number diminished.

P. and A. Photograph

"HELP!"

On the plank in front of this crashed house some one scrawled, "Here are several ten men under the roof. Do please save them."

417 QUAKES IN 30 HOURS

The number of earthquakes felt in the city indicates that from 6 p. m. until midnight, January 11, shocks, accompanied by rumblings, were felt approximately every twenty minutes; from midnight to 3 a. m. of January 12 every ten minutes, and thereafter, until 5 a. m., every five minutes. Then came a respite from strongly felt shocks for about three hours, during which period there were five quakes at very irregular times.

Four hundred seventeen earthquakes were thus recorded at Kagoshima between 4 a. m., January 11, and 10 a. m. January 12, after which the main eruption of Sakurajima began. Counting the shocks of the 10th, which had begun about 1 p. m., there was immediate forewarning in noises and shakes for forty-five hours prior to the explosion.

These warnings were heeded. Every available sampan sculled with frantic speed back and forth across the channel all day Sunday, January 11, moving the natives of the island, their bedding, mats, rice bags, and canary birds, to the mainland. By Monday the army, navy, and other government departments, railways and steamship lines were all helping. Sunday afternoon, about 2 o'clock, during a period of violent quaking, a report came from Tarumi, southeast of Sakurajima, that white smoke was seen rising from the middle of the volcano.

THE SAKURAJIMA OUTBREAK

The Monday period of seismic activity was strikingly terminated and relieved by the volcanic outbreak of 10 o'clock.

P. and A. Photograph

A BIRD'S-EYE VIEW OF YOKOHAMA AFTER THE EARTHQUAKE OF SEPTEMBER, 1923

The most destructive earthquake in the history of man began about noon, on September 1, in the neighborhood of Tokyo and Yokohama, entirely destroying the latter city and about 70 per cent of the capital. Fires spread rapidly. The water mains being broken, little could be done to check the flames.

Sakurajima in the early morning had been veiled by a cloud, but the incessant din of rumbling diminished after 5 a. m. There may have been a summit landslip. Continual quick explosions were heard from 9 o'clock on, and a small puff of white vapor was reported at that time; but it was not until 10 o'clock, when all the fog clouds were dissipated, that the great volcanic drama unfolded under splendid photographic illumination.

The climax came at 10:05, when, in the middle of the side of the mountain toward Kagoshima, the awe-stricken people saw the hard profile of a swelling balloon of black smoke rise majestically from the ground where, an hour before, were orange orchards, terraced fields of sugar cane, and gardens of radishes (see pages 452 and 454).

The peasants rubbed their eyes; the children in the schools ran to the windows to look. They were instantly dismissed.

One of the most naïve descriptions of the scene has been furnished by a Japanese boy of fourteen, a student of English in the language class of an American teacher in the high school at Kagoshima. He wrote: "Monster rocks went horizontally from the down to the up, with smokes on their behind."

The jet of smoke from the western vent of the volcano shot up obliquely, then straightened to a vertical column, and rose 30,000 feet into the sky, first club-shaped, then assuming the form of a great lily. Finally, the top bent majestically eastward, like a triumphal arch built to span a mountain. The upper volutes of dust were caught by some countercurrents of wind, which strewed the powder all over central Japan.

Ten minutes after the first outbreak a similar cauliflower column rose from the east flank of the volcano, but this was dwarfed by the towering western shaft with which it eventually merged.

With occasional lulls, but with ever-increasing violence, the booming concussions of the eruption grew more and more terrible. Flashes of lightning danced through the great billows of smoke and dust (see illustration, page 457), and, in the lower portion of the great, black column, vertical lines of upward streaming rocks, bombs, sand, and smoke, curling as high as the mountain itself, could be seen from time to time. In addition, there were outward spurts of large, glowing blocks, which left curving trails of vapor in their path. At night these red-hot missiles could be seen to darken after passing the crest of their curved courses, and gradually they were blotted out by the darkness.

The fall of ash over the city of Kagoshima began an hour and ten minutes after the eruption started, and continued intermittently until the following evening (see page 463). At 5 o'clock in the afternoon the eruption waxed in fury. Extra-heavy earthquakes in the vicinity of Arimura, on the southeast coast of Sakurajima Island (see page 454) were felt, and ships in the bay reported that the maximum height of ejection of material was reached an hour later.

EARTHQUAKE CAUSES ONLY LOSS OF LIFE

The crisis, which resulted in the only loss of life during the disaster, occurred at 6:29, when a terrific earthquake threw down walls and buildings at Kagoshima, dislodged boulders from cliffs, and interrupted railway and telegraph services.

Fugitives were trapped in landslides, and a tidal wave, with a ten-foot swing, caused serious damage to small boats in the harbor. Thirty-five persons were crushed to death and 112 were injured.

This quake is to be classed as a "world shaker," for it was recorded on seismographs in Europe.

The lava flows from the volcano had begun and the gas explosions had relieved the under earth of millions of tons of matter, so that this quake was probably the evidence of a deep movement, or settling, that had begun along the great chain of Ryu-Kyu volcanoes, extending from Kyushu to Taiwan (Formosa) in a string of islets 900 miles to the southwest.

Simultaneously with the occurrence of the big quake a sudden lava glow was observed on the smoke coming from the volcano. This continued for some time.

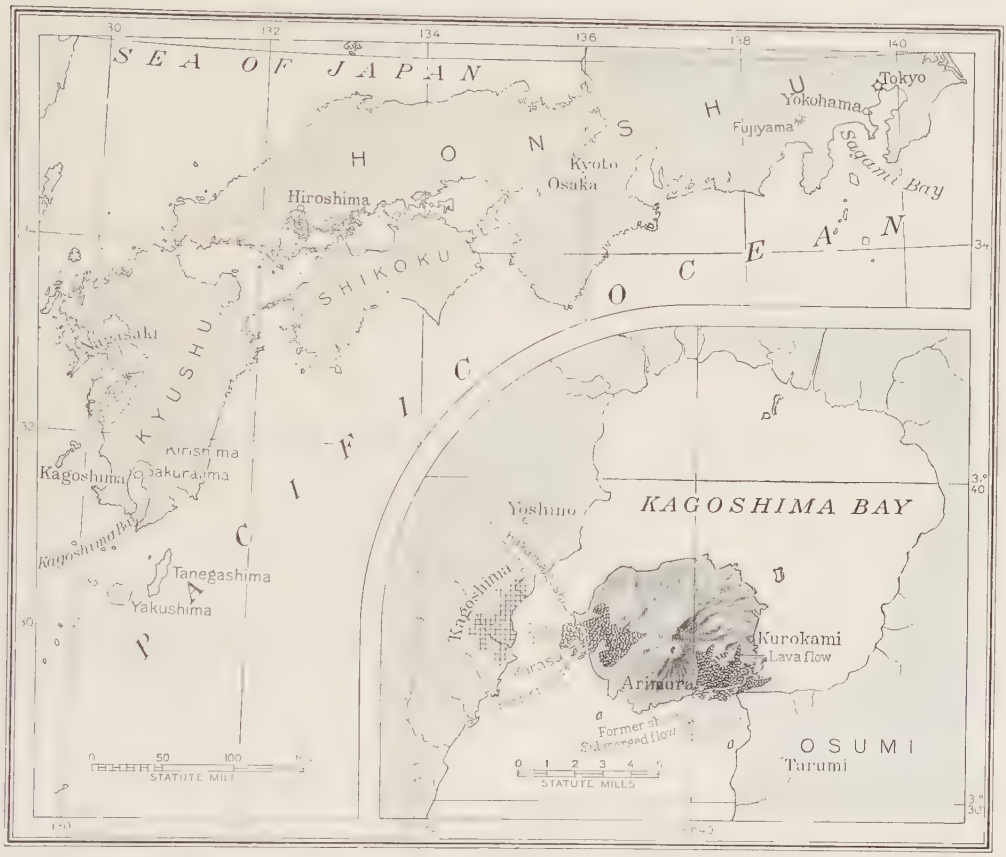
According to the barograph records, the air concussions reached a maximum at midnight of January 12. These were so severe that American teachers, who remained in Kagoshima throughout the eruption, testified that their ears were aching as a result of the incessant detonations and the everlasting rattling of the

SOLDIERS DISTRIBUTING FOOD AND OTHER NECESSITIES TO THE STRICKEN IN TOKYO

P. and A. Photographs

REFUGEES LEAVING TOKYO

From the railway station of Nippori, a suburb of the capital, thousands made their way toward the northeastern part of the empire. Japanese soldiers put Tokyo under efficient military control and in the metropolitan district there were few of those ghastly incidents which occurred in the outlying portions of the earthquake area.



Drawn by Bumstead and Darley, after Omori

A MAP OF SAKURAJIMA, SHOWING THE LAVA FLOWS OF JAPAN'S GREATEST VOLCANIC ERUPTION

paper partitions of the houses. These teachers continued to send off their correspondence in the midst of this veritable bombardment of sound.

It seems probable that the big earthquake of Monday evening was the climax of strains in the crust of the earth's surface, and that the midnight detonations were the climax of the explosions in the lava column that had been released. The glow which occurred at the time of the quake was probably due to the spouting lava.

PROGRESS OF THE ERUPTION

The outbreak of January 12 was followed by months of intense activity. The lava overflowed new craters, poured into the sea, and created new islands.

There was a short lull on the morning of the 13th, but at 4:09 p. m. there was a startling earth shock, and at about this time lava flows emerged from the slope of Sakurajima nearest Kagoshima.

The gassy flux which at first "went up in smoke" was now contracting to a more fluent substance, moving rapidly the first few hours and then settling down to a clinkery flow, looking more like a glacial moraine than a flood. It was a hypersthene-hornblende andesite — refractory stuff that crystallized in rough sprouts and tumbled fragments, like the AA lava of Hawaiian folklore.*

Similar lava was vomited from eastern vents, which were still in full blast when the writer arrived on the scene, in February.

Explosions hurled up "bread crust"

* See "The Hawaiian Islands," by Gilbert Grosvenor, in the NATIONAL GEOGRAPHIC MAGAZINE for February, 1924.

THE POTTER AND THE POTTER'S WHEEL

The province where the Sakurajima disaster occurred, in the southernmost end of Kyushu, is the home of Japan's famous Satsuma pottery.

Photographs by Suito

THE REAPERS: A SCENE NEAR KAGOSHIMA

Millions of dollars' worth of crops were destroyed all over Satsuma and Osumi by the fine ash which plastered the soil (see text, page 468).

A TOY SHOP IN A KAGOSHIMA STREET

The vender has in his hand the counting-board (abacus), without which no computing, however simple, is done.

Photographs by Suito

A POTTERY SHOP OF KAGOSHIMA

"Kago" ware, named after this city, is well known to collectors. The Satsuma kilns were founded by two Korean potters late in the 16th century.

Photograph from T. A. Jaggar

LOWER WESTERN CRATER OF SAKURAJIMA EXPLODING THROUGH THE LAVA FLOW, SEEN FROM ABOVE, LOOKING TOWARD KAGOSHIMA

bombs of semimolten stuff at the fountainheads of the flows, and the steep lava fronts, 15 feet high, caved in and sent up avalanche clouds, and rumbled with tumbling fragments, each as big as a small house.

When the lava reached the sea this hot front made millions of rising tails of cottony steam (see page 469).

A MATCHLESS PYROTECHNIC DISPLAY

The climax of luminosity, accompanied by terrible detonations and concussions, was described as follows by one of the American teachers, Mr. Hoyer:

"On the evening of the 13th, skyrockets of scoria shot from the crater in all directions. Over the mountain hung a huge black cloud of ash in which lightning was zigzagging in long, white streaks (see illustration, page 457). Suddenly, at 8:15 p. m., a tremendous force sent a fountain of fire more than 6,000 feet into the air. Then this brilliant column fell, and from an incredible height tumbled like a vast Niagara of fire in wide streams on to the island and into the water!

"Smaller fire holes underneath were spouting black clouds, and the tumbling fire seemed to strike rocky obstructions in these spurts and, like water, sent a fiery mist far into the night.

"Under these gigantic falls flowed sparkling cascades of fire toward the sea. They were rapids of raining ash still red hot as they fell and struck.

"Lava streams rushed like molten iron into ravines, filling them, solidifying and piling up in fields of enormous dimensions. This pyrotechnic display continued until midnight.

"When at its height, the tumbling cone spread fire in the remaining forest and villages. The entire western coast line was ablaze. Some of the villages had been built shoestring-fashion along the shore, and the fire ran rapidly along these. Flames leaped high and the remaining embers glowed like a furnace for hours."

The "rapids of raining ash" on this occasion behaved like the famous downrushing blast of Mont Pelée, on the island of Martinique, in the eruption of 1902, setting fire to houses which had resisted the previous bombardment, obliterating the village of Hakamagoshi with bombs

Photograph by Osaka Mainichi Shimbun

EXPLORING PARTY RETURNING FROM THE WESTERN CRATERS AND LAVA FLOW ON THE THIRD DAY OF THE SAKURAJIMA ERUPTION (SEE ALSO PAGE 458)

and gravel and throwing down the trees in lines with their tops away from the mountain, the stumps shredded and punctured by flying stones.

This was the moment of extreme danger for Kagoshima, for the incandescent blast was straight toward the city, scarcely more than two miles away, but its force was spent over the channel.

If the entire eruption had concentrated about a western crater, Kagoshima would have been destroyed; but the outcome was happy for the city, in that explosive activity in the west craters ceased after January 20; the lava from that time became sluggish on that side and concentrated its activity at the eastern craters, which continued exploding into the summer months.

After January 14 the eruption quieted gradually (see page 456). Immense patches of pumice floated on the bay, brown and white roundish fragments, one to four inches in diameter, at first in such masses as to impede boats (see pages 463 and 465). The lava pushed out into promontories and tongues submerged by the sea.

As the wind was mostly eastward, the heavy ash fall accumulated deepest in the sparsely inhabited Osumi country (see illustrations, pages 467 and 468).

The western lava flow was more than three miles long, to the sea front, and varied in width from less than a mile near the source to two miles in the region of the former shore line (see pages 456 and 458).

Photograph from T. A. Jaggar

TERRACED FARM LANDS UNDER ASH: SOUTH SIDE OF SAKURAJIMA AT ARIMURA

The more voluminous east lava flow came from three pairs of craters, each pair consisting of an explosion hole above and a lava outlet below. All three were in action in February when I saw them—gaping fissures in a line, exploding like artillery, with piles of débris on either hand. From the heights one could see a snakelike stream of glowing lava flowing between boulders, at the rate of a hundred feet per hour on the surface, to a region farther down the slope, where the motion became lost to view.

The flows divided into lobes at their lower ends, and one of these buried Seto and filled the strait which had separated the island from the Osumi mainland. The historic moment when Sakurajima Island became a peninsula occurred on the afternoon of February 1, when the last pools of boiling salt water were obliterated by the tumbling slag, which began to pile up against the steep Osumi shore. Twice thereafter the road along the shore had to be moved higher, as the lava buried it. During the month this lava rose to a height of 300 feet above sea-level, where before there had been water 200 feet deep (see page 462).

On February 19, I tested with a thermometer the sea water over the submarine lava lobe off the Osumi shore. Where the strait had been closed and near the lava front, the temperature was 138 degrees Fahrenheit. We rowed out to a ship, trailing the thermometer in the water and passing across a submarine tongue of hot lava, as was afterwards proved by soundings. First, the temperature steadily fell to 100 degrees; then rose to 115°, 120°, 125°, 132°, and 138° (over the submerged lava tongue); then it began falling—118°, 115°, 102°, 80°, and finally, at the ship's side, 66°. It was a singular experience to row through such hot water, with clouds of vapor on all sides, knowing that to capsize would mean death.

There was a recrudescence of big explosions at the eastern craters, reaching a maximum March 11 and 12, when Mr. F. A. Perret was studying the volcano. He described cauliflower explosions brightly incandescent in full daylight, reaching a height of 10,000 feet, and blowholes of paroxysmal gas puffing almost continuously on the flowing lava at

terrific pressure. Mr. Perret was caught near flowing lava that masked a crater battery which had a habit of firing once in five hours. It exploded through the lava flow, throwing out a shower of bombs that inflicted some injury upon him and his attendant. Fortunately, very large boulders were at hand, under which they took refuge.

Photograph from T. A. Jaggar

A GIGANTIC BREAD-CRUST BOMB ON THE EDGE OF KIRISHIMA CRATER

This volcano, north of Sakurajima, was in eruption two months before the outbreak of the latter (see text, page 444).

HOW THE PEOPLE WERE CARED FOR

The remarkable record of life-saving in the Sakurajima eruption was partly due to good luck, but also to the instinct of the people, to the wisdom of the government, and to scientific societies. Army, navy, and police officials took control; steamship companies, newspaper men, and high-school boys organized rescuing expeditions to the island, in the face of the terrifying explosions, and carried away every living soul they could find.

It is said that an aged woman in Kurokami, below the east craters, refused to go. She lived through the eruption, in one of the steeper thatch-roofed houses, whence the ash and sand slid off, until the heap reached the eaves. Such buildings stood where the flat-roofed structures collapsed (see illustration, page 464). Twenty or thirty persons were injured and taken to the hospitals, and two persons jumped into the sea and were drowned, but, so far as is known, *the volcano killed no one.*

People camped in temple grounds and in cemeteries, business houses offered relief, and 5,000 destitutes were accommodated in schools, temples, and public buildings (see page 460). A continuous caravan of emigrants moved across country.

Then came the earthquake, and consternation reigned. January 13 was a day of general exodus, and Mr. Hoyer "walked through the deserted streets of Kagoshima without meeting more than five people in a mile; shops were nailed shut; soldiers took up their quarters on street corners and guards walked their beats."

There were no ghouls and no looters. Officials remained at their posts, but the population fled. The general in charge of an army detachment that was bound

Photograph from T. A. Jaggar

SECOND STAGE IN THE ADVANCE OF THE WESTERN LAVA FLOW, ON THE FOURTH DAY OF THE SAKURAJIMA ERUPTION: LAVA HAS REACHED THE SEA BACK OF KARASU ISLAND (SEE ALSO PAGE 469)

Photograph by Osaka Mainichi Shimbun

SAKURAJIMA FROM KAGOSHIMA ON THE THIRD NIGHT OF THE ERUPTION: LIGHTNING FLASHES ARE TO BE SEEN IN THE EXPLOSION CLOUD

An old Japanese manuscript, describing an earlier eruption of Sakurajima, gives this vivid word picture: "It was so dark that it seemed as though powdered ink filled the air; thunder and quakings came together and the whole world was noise."

Photograph by Osaka Mainichi Shimbun

AN EXPLORING PARTY AT THE WESTERN LAVA FRONT ON THE THIRD DAY OF THE ERUPTION

Note the handkerchiefs over the faces to protect throats from hydrochloric acid fumes.

Photograph by Osaka Mainichi Shimbun

THE EASTERN LINE OF EXPLOSION CRATERS AND THEIR FILLED-UP CONES AND VENTS; TENTH DAY OF THE ERUPTION

REFUGEES FROM SAKURAJIMA FLEEING WITH THEIR HOUSEHOLD GOODS

Twenty-two thousand persons left the island, and not a single death was attributable to the volcano directly (see text, page 455).

Photographs from T. A. Jaggar

REFUGEES ENCAMPED IN TEMPLE GROUNDS IN KAGOSHIMA

Everyone was cared for, and in outlying towns the young men's clubs organized hospitality committees which were very efficient (see text, page 462).

Photograph from T. A. Jaggar

HIGH-SCHOOL BOYS BATHING IN HOT SEA-WATER ABOVE THE LAVA

Whenever an exploring party went into danger the high-school boys were to be found (see text, page 455).

Photograph by Suito

A GROUP OF HAPPY REFUGEES

"The children in the schools ran to the windows to look. They were instantly dismissed" (see page 447).

Photograph from T. A. Jaggar

THE EASTERN MAIN CRATER AND THE SOUTHEAST LAVA FRONT: SAKURAJIMA

The block lava is piled more than 300 feet above sea-level (see text, page 454). The water in the foreground is hot.

for the Ryu-Kyu Islands diverted his transports to rescue work. The young men's clubs of the outlying towns received the refugees, suppressed profiteering, and systematically provided lodgings.

Professor Sasamoto and other teachers in the higher schools of Kagoshima were familiar with the tragedy at St. Pierre at the time of the Mont Pelée eruption; they knew Sakurajima and their views had been made public.

Mr. Katsuno, director of the observatory, kept steadfastly the record of earthquakes and atmospheric changes, and did not commit hara-kiri, as was reported at the time through the malignant gossip of carping critics. It is an astonishing commentary on the advanced ideas of modern Japan that they should blame weather observers for not knowing in advance all about volcanoes!

On January 14 Dr. Omori arrived, brought two new seismographs, and posted an official bulletin to the effect that the worst was over; so that thereafter the population straggled back into the city

Photograph from T. A. Jaggar

PHOTOGRAPH EXPOSED TWENTY SECONDS IN AN ASH STORM IN KAGOSHIMA DURING THE SAKURAJIMA ERUPTION

The effect is like a snowstorm. Celluloid goggles to protect the eyes were in great demand.

Photograph by T. A. Jaggar

FLOATING PUMICE IN KAGOSHIMA DOCKS MAKING THE SURFACE OF THE WATER LOOK LIKE A SAND BEACH (SEE TEXT, PAGE 453)

Photograph from T. A. Jaggar

A HOMELESS WANDERER SEARCHING FOR HIS FLAT-ROOFED DWELLING AT KUROKAMI, NEAR THE EASTERN CRATERS
(SEE TEXT, PAGE 455)

Photograph by Osaka Mainichi Shimbun

A BIT OF THE OSUMI COAST, EAST SIDE OF KAGOSHIMA BAY, SHOWING A SWAMPED SAMPAN IN A SEA OF PUMICE

The pumice shows the wave action. This illustration recalls an old Japanese chronicler's account of the Sakurajima eruption of 1779: "These light stones were blown out from burning holes on the mountain; they fell in the water and would not sink, making the sea look as though covered with matting." This account relates that three men started across the bay on foot, the packed pumice acting as a bridge; one man broke through and lost his life.

Photograph from T. A. Jaggar

THE FINAL STAGE OF EXPLOSIVE ERUPTION OF SAKURAJIMA, AFTER LAVA HAD BEEN FLOWING MORE THAN A DAY

and the shops and hotels were opened. The behavior of the volcano confirmed his dictum.

Railway connections were broken for one day only and telegraph connections for a few days. Relief funds poured in from all over the world, but there was no suggestion of "graft." The government authorities promptly took an inventory of damage and immediate needs, and the foreign relief money went to purchase permanent homes for the desolated Sakurajima fugitives on the near-by island of Tanegashima.

Fifteen thousand people had dwelt within the death zone of the volcano. Seven out of eighteen villages on the island were destroyed. Fifteen lives were lost by earthquake in Kagoshima city and twenty others elsewhere. Probably ninety-five thousand people moved across country and were cared for by spontaneous hospitality (see page 462). The Japanese show the Oriental quality of nomads, content with few possessions, small papery houses and light, portable household goods.

The ash fall varied in depth from 70

Photograph from T. A. Jaggar

ASH AND PUMICE AT KUROKAMI, NORTHEAST OF SAKURAJIMA

"The ash fall varied in depths from 70 inches, near the volcano, to a thin film 30 miles away" (see text, pages 466 and 468).

Photograph from T. A. Jaggar

A LESSON IN HOUSE-BUILDING FOR DWELLERS ON VOLCANOES

Flat roofs accumulate ash and generally collapse, while steep ones make a toboggan slide and the ash slips off (see text, page 455).

inches near the volcano to a thin film 30 miles away. On the second day (13th) it fell in Osaka, 350 miles to the northeast, and on the third day in Tokyo, 600 miles to the northeast.

More than 4,000 acres of hard lava, above sea-level, poured out in the first two months; 2,148 buildings were burned and 400 collapsed. The damage was estimated at $19,000,000, the number of people transferred to new homes was 28,096, the relief fund amounted to $2,500,000, and 18,446 destitutes were being provided for in February. There was much damage by ash and pumice that had to be removed from devastated districts still habitable.

THE GROUND WAS HEAVED OR LOWERED

Careful measurements by engineers immediately after the Sakurajima eruption showed that a place on the mountain which was an old survey station had been heaved up 24 feet, and that a place in the bottom of the bay to the north had subsided 10 feet. These facts are interpreted to mean that the actual mountain was swollen by the lava inside, but that the land all around for a distance of 75 miles, more or less, had subsided, owing to the great volume of lava withdrawn from what otherwise would have been left as a void in the depths of the earth's crust.

Careful levelings have shown that such gradual subsidence, lessening at increasing distances from the volcanic center, actually occurred.

Similar heaving occurred in north Japan in 1910, when Usu volcano erupted, without, however, emitting any lava. A calculated tilting of the ground at these two volcanoes has shown that at Sakurajima a leveled slab would have tipped five minutes of arc, and at Usu about ten minutes. This means that at these two places a carefully built and plumbed pier in an astronomical observatory, if there had been such, would have been thrown out of plumb permanently by from a twelfth to a sixth of a degree.

Such heavings and shovings of great blocks of the earth's crust are common in earthquakes, and in the San Francisco

Photograph from T. A. Jaggar

FOURTH STAGE IN THE ADVANCE OF THE WESTERN LAVA FLOW

Karasu Island is being buried under lava, which, upon reaching the sea, makes millions of rising tails of cottony steam (see text, page 452).

disaster the sidewise movement between two adjacent pieces of ground was as much as fifteen feet. A great earthquake in Alaska in 1899 lifted the rocky shore line more than forty feet, as reported by a National Geographic Society expedition, which was sent to measure it.

COMPARISON WITH THE TOKYO EARTHQUAKE

The appalling cataclysm which has recently stricken Japan, destroying most of Yokohama and two-thirds of Tokyo (see pages 441-446, and 448), was occasioned by sudden big movements about the volcanic rift in the bottom of the sea a few miles southeast of Fujisan (Fujiyama).

The bottom of Sagami Bay sank 900 feet, as if a submarine crater had caved in. The sides of the bay slumped on the slopes and piled up along the bottom edge of those slopes, so as to change the soundings from 300 to 1,200 feet, in some places the depth being increased, in others lessened.

With all these colossal changes in the sea bottom, the solid shore lines were lifted and lowered by from one to nine feet only, indicating an upheaval and a tilting over a wide area affecting the entire cup surrounding Sagami Bay.

These relatively small figures for the shore lines indicate a difference in the materials composing the bottom of the bay and those of the shore line. Moreover, the subsidence of the middle of the bay was probably a slumping of blocks into the great volcanic rift of the Fuji chain of volcanoes.

On the other hand, the upheaval of eastern Japan for 100 miles outward from the volcanic center was probably due to some swelling action of the lava under the earth's crust. This lava failed to escape, just as in the case of Usu Volcano (see text, page 468), and so its energy was satisfied by a movement of inward swelling instead of outwelling, and elevation of the land was the result.

These movements of swelling and tilting have been studied attentively at the Hawaiian Volcano Observatory, under the United States Weather Bureau. For the man of science they have the advan-

tage that they are going on all the time at active volcanoes and probably also in all earthquake belts; they reveal the actions of the lava underground, even when there is no lava to be seen above ground.

A HOPEFUL LINE OF RESEARCH

This is a very hopeful line of research, as the earthquakes are often accompanied by sudden tilts, and these tippings away from some point on the surface of the earth make that point a very suggestive, dramatic, and portentous place.

It all seems to suggest that such a center of tilting may become a center of sudden breaking or sudden volcanic explosion. In Hawaii the center is apt to be the middle crater of the volcanic system, and we have measured upheavals produced by an eruption which check perfectly with the rise and fall of the lava.

Contrasting the Sakurajima eruption with what happened at the Tokyo earthquake, the indications are that, in the former, there was an accumulated upward pressure, while tide gauges and anchorages at the stream mouths had shown for many years that the shore line of Kagoshima Bay was rising. Near Tokyo, on the other hand, there is good reason to believe that certain shore lines in the last few years have been sinking.

A wharfmaster on the Bōshu Peninsula, east of Tokyo, told me, during my investigations following the cataclysm of September, 1923, that for twenty years past the sea had been encroaching and had forced him to build a concrete wall. This means that the land beneath his wharf had been slowly going down. When the earthquake came that whole region was shoved up vertically; this man's wharf was wrecked and was left high and dry.

At Kagoshima Bay, when the Sakurajima eruption came and quantities of lava were poured out from underground, the whole shore line of the bay roundabout, which had been rising for twenty years, suddenly subsided several feet.

The difference in the phenomena accompanying the two events, it would seem, is that a volcanic eruption is the relief by outpouring of an accumulation of volcanic matter which for years has been pressing upward, whereas a great earthquake of the Tokyo-Yokohama kind may be a sudden upward pressure over a considerable area due to some expansion of volcanic matter underground which has previously been subsiding or contracting.

Whatever the facts, this doctrine for the great earthquake checks with the evidence that makes the earthquake center coincident with the Fuji belt of active volcanoes, where, under Sagami Bay, the bottom sank 900 feet.

Furthermore, Dr. Omori's tables of earthquake frequency at Tokyo for the last twenty years show that there has been a steady dwindling in numbers of shocks registered each year by the seismographs.

It is only a question of time, and of making additional observations at several volcanoes, for science to learn more about earthquake portents than anyone dreamed of fifty years ago. The late honored Professor Omori was a martyr to science in the Tokyo earthquake. He devoted all the later years of his life to studying the relation of earthquakes to active volcanoes in Japan. He found that volcanoes were the keys to the earthquake problem. He had almost reached the point of unlocking the mystery. All honor to his memory, and may science take up the key where he laid it down.

Notice of change of address of your GEOGRAPHIC MAGAZINE *should be received in the office of the National Geographic Society by the first of the month to affect the following month's issue. For instance, if you desire the address changed for your June number, the Society should be notified of your new address not later than May first.*

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SURVEYING THE GRAND CANYON OF THE COLORADO

An Account of the 1923 Boating Expedition of the United States Geological Survey

BY LEWIS R. FREEMAN

SEVEN of our United States are vitally interested in the great Colorado River which, with its major tributaries, has a length of more than 1,700 miles and the phenomenal fall of 10,000 feet between its head waters in the Rocky Mountains and its mouth in the Gulf of California.

The control of the flood waters of this mighty river and the utilization of the power which now goes to waste in its drop of nearly two vertical miles, as well as the vast irrigation projects which have been and are yet to be developed along its course, directly concern the citizens of Wyoming, Colorado, Utah, New Mexico, Arizona, Nevada, California, and our neighboring Republic of Mexico.

The most spectacular section of the Colorado River Basin is the Grand Canyon, with its mile-high, multihued walls, which in any list of natural wonders of the world inevitably stands among the first.

More than half a century ago John Wesley Powell made two daring and historic voyages through this Grand Canyon and later published some remarkably interesting narratives of his explorations.

Probably the work of no other explorer of the nineteenth century—not even that of Stanley and Livingstone in Africa—has survived a period of fifty years with so little modification from the observations of those who followed.

But with the vast projects for irrigation, flood control and power development which now engage the thoughts of empire-builders of our West, more specific information than that obtained in 1872 has become essential. Therefore, in the summer of 1923, the United States Geological Survey, a government bureau which in large measure owes its establishment to Powell, the pioneer explorer of the Colorado, organized an expedition to make a new map of the Grand Canyon—the last stretch of the great river which remained to be accurately surveyed.

PERSONNEL OF THE PARTY

Claude H. Birdseye, Chief Topographic Engineer of the Geological Survey, was named to organize and head the expedition. With the surveying of Mount Rainier and of the crater of Kilauea and other notable field work to his credit, he was especially well fitted for the arduous task.

The Geological Survey party assembled in Flagstaff, Arizona, on July 15. The leader, a topographic engineer, a hydraulic engineer, a geologist, a rodman, a cook, and one boatman for each of four boats comprised the party.

R. W. Burchard, the topographic engineer, had surveyed the Boulder Canyon dam site, as well as most of the river between the foot of the Grand Canyon and

Photograph by E. C. La Rue

ONE OF THE CANYON EXPEDITION BOATS BEING TRANSPORTED BY MOTOR TRUCK TO LEES FERRY

At some points on the road from Flagstaff, Arizona, it was necessary to rebuild the road (see text, page 473).

Photograph by Lewis R. Freeman

THE BOATHOUSE AT LEES FERRY, WITH VERMILION CLIFFS IN THE DISTANCE

Three of the boats to be used by the expedition were here when the party arrived (see text, page 473).

THE SURVEY PARTY AT LEES FERRY

Left to right: Leigh Lint, boatman; H. E. Blake, boatman; Frank Word, cook; C. H. Birdseye, leader of the expedition; R. C. Moore, geologist; R. W. Burchard, topographer; E. C. La Rue, hydraulic engineer; Lewis R. Freeman, boatman, and Emery C. Kolb, head boatman.

Needles; also 35 miles at the lower end of the Grand Canyon itself.

R. C. Moore, of the University of Kansas, geologist of the expedition, owed his appointment to the fact that he is an authority on the geology of the middle Colorado Canyon region, a former college athlete, and a veteran of many a hard summer's field work in the desert West.

The hydraulic engineer of the expedition was E. C. La Rue, of the Water Resources Branch of the Geological Survey, who qualified for that appointment through many years of specialization on Colorado River problems.

The boatmen of the expedition were H. E. Blake and Leigh Lint, two trappers and rivermen from the Northwest; Emery Kolb, the Grand Canyon photographer, and myself. Frank Dodge, the rodman, was also a competent boatman and by long odds the best swimmer in the expedition.

AT THE POINT OF EMBARKATION

Three of the boats to be used by the expedition were already at Lees Ferry; a fourth, built at Los Angeles Harbor, awaited us at Flagstaff. A cradle of heavy timbers was built on the truck to relieve the strain on the latter craft during a 140-mile run over ungraded mountain and desert roads to the river. With 10 feet of overhang behind the truck, men had to ride the radiator on the climbs to keep that vehicle from rearing like a balky horse (see page 472).

A second truck and two autos carried the remainder of the party and outfit.

Leaving Flagstaff at noon of the 18th, we camped that night at the Cedar Ridge trading post of the Navajo Indian Reservation. Pushing on early the following morning, we were delayed by the necessity of repairing washouts from a recent cloud-burst in the road along Tanners Wash. In spite of the tendency of the overhanging tail of the boat to wag the truck, little real trouble was encountered.

The gorge of Marble Canyon was as baffling as ever in its concealment, as we approached it across the plateau. It was impossible to say with certainty, judging

Drawn by Charles E. Riddiford

A SKETCH MAP OF THE GRAND CANYON: THE 1923 EXPEDITION BEGAN ITS VOYAGE AT LEES FERRY

Twenty-one new dam sites were surveyed by the Grand Canyon party and the Diamond Creek dam site was resurveyed. The Geological Survey is now preparing a report which will give details of the possibilities for power development, flood control, and irrigation at each of these sites. The complete course of the Colorado River is shown on the Map of North America which is issued as a supplement with this number of THE GEOGRAPHIC

only from what met the eye, that even so much as an arroyo or gully intervened between the road and the wall of the Vermilion Cliffs towering against the northwestern sky. Yet the ever-deepening chasm of the world's most profound canyon was at times less than a mile distant from our winding desert track.

At the old Mormon dugway we were confronted with the alternative of unloading the boat and taking it down to the river by a long-unused stretch of grade or

Photograph by E. C. La Rue

THE "MARBLE" BEING SOAKED READY FOR THE TRIP THROUGH THE GRAND CANYON

This, one of the three boats loaned to the expedition, had been exposed to sun and dry air for two years. It had to be thoroughly reconditioned (see text, page 479).

trying to run it through on the truck. Fortunately, we decided upon the latter. Notwithstanding the fears of the driver that the boat was too long for the shelving curves, it rode through with plenty to spare.

Camp was made at the boathouse of the Southern California Edison Company, on the right bank of the river, just below the cable ferry. A temperature of 110° Fahrenheit in the shade, with considerable humidity, was trying, after the exhilarating mountain air of Flagstaff. As this was the sort of thing to be expected for the next month and a half, however, nothing was to be gained by waiting for a cooler spell.

THE MOUTH OF THE PARIA HAS DRAMATIC HISTORY

The end-of-the-day plunge in the river that evening after work was over became an established feature for many weeks. The water was red with mud at its clearest; but it was a clean sort of mud, as mud goes, and came off freely under vigorous toweling. Until we were far enough down-river to be exposed to the liquid filth poured out by the floods of the Little Colorado, our evening, morning, and interim dips were refreshing.

The mouth of the Paria, from where our start was to be made, is one of the most historic points on the Colorado. Fray Escalante, searching for the ford which has since been called "The Crossing of the Fathers," camped there in 1776, seeking a way to reach the left bank of the Colorado. The "great gray cliff" where his party starved on horse meat and toasted cactus fruit is readily recognizable.

James Pattie, the trapper, passing here in the middle twenties, expressed his relief at coming out even temporarily from "the horrid mountains."

Powell, making an overnight camp at the Paria in early August of 1869, pushed off into the depths of Marble Canyon the following morning, on the final stage of his pioneer voyage. He met neither Indians nor whites in the valley at that time, but three years later his second expedition found the Mormon renegade, John

Photograph by E. C. La Rue

LEES FERRY FROM THE LEFT BANK

This point on the Colorado derives its name from a renegade Mormon who, after eluding officers of the law, cultivated a fertile patch of ground here. He was eventually captured, tried, and executed as the instigator of the Mountain Meadows Massacre. The voyage of the 1923 expedition from Lees Ferry to Needles, where the party disbanded, required 80 days.

D. Lee, farming a patch of fertile overflow land above the ford which still bears his name.

Lee was a fugitive from justice, being widely sought by the Federal authorities as the instigator of the Mountain Meadows Massacre of 1857, a crime for which he was finally tried, found guilty, and executed.

Dellenbaugh writes in delightful vein of the way in which he and one or two of the younger members of the second Powell party helped Sister Emma (Mrs. Lee XVIIIth) irrigate her melon patches, and how Jack Hillers got no end of a rise from the nervous fugitive by cocking a gun behind him during Lee's Sunday sermons.

The Brown-Stanton party, surveying for a railroad through the Grand Canyon, halted and refitted at Lees Ferry in July, 1889, after losing much of their inadequate outfit in the rapids of Cataract Canyon. Three of the eight men of the reduced party were lost within a few days of putting into Marble Canyon, forcing the temporary abandonment of the expedition.

Stanton's reorganized party had Christmas dinner at the Ferry six months later, before resuming the uncompleted survey. A few days afterward that indomitable leader was back again, this time to seek help to bring out his photographer, who had broken his leg by a 20-foot fall.

No place on the river has the power to awaken more memories of the past than Lees Ferry, but, strangely, little remains that can be touched save by the imagination. Lee's first log cabin and his four-way lookout on a point above the Paria are still

there, but all we ever found that pointed to one of the early navigators was the name HISLOP, pricked in large capitals on the red sandstone of the house now occupied by the Government hydrographer. That could only have been the stout Scotch engineer, John Hislop, Stanton's right-hand man on both voyages. Hislop, after surviving the passage of the Grand Canyon rapids and several years in pioneering railroad work in Alaska, was finally killed by a street-car while home on a vacation.

EXPEDITION'S BOATS WERE FLAT-BOTTOMED AND DECKED OVER

The four boats used on our expedition, while differing slightly in size and details, were all of the flat-bottomed, decked-over, one-man type that is appropriately called the Galloway-Stone. The somewhat crude original was designed and built by Nathan Galloway, a Mormon hunter, for use on his lone-hand trapping expeditions to stretches of the upper Colorado canyons.

On the sound theory that it is better to avoid a rock in a light boat than to hit it with a heavy one, Galloway sacrificed strength for handiness, but built a boat which he repeatedly ran single-handed through rapids in which the large, heavy boats of Powell and Stanton had encountered much trouble.

When Julius F. Stone, an Ohio manufacturer, scientist, and sportsman, decided to make a voyage to photograph and study the geology of the Colorado River canyons in 1909, he had Galloway come to his home in Columbus, where the two men put their heads together to build an ideal boat along the lines of that already used with such success by the Utah trapper.

The present type of the Grand Canyon boat was the result. It was entirely decked over, except for a cockpit for a single oarsman, and weighed less than 250 pounds. Its length was 16 feet 4 inches, its beam 46 inches, and its depth 16 inches. The material was Michigan white pine five-eighths of an inch thick.

The four boats of this type built to Mr. Stone's order were used with signal success on his voyage through the canyons. The run from Green River, Wyoming, to Needles, California, was made in one week over two months.

Both Stone and Galloway brought their boats through all the way without an upset and with but a single little collision each while under control of the oars—by long odds the best record ever made, both for time and for skillful boatmanship.

THE KOLBS DOUBLED WEIGHT OF BOATS TO INCREASE STRENGTH

When the Kolb Brothers were planning their photographic expedition through the Colorado canyons in 1911, Mr. Stone furnished them with blue prints of the design of the boat which had served him so well. Desiring a boat of greater strength, the photographers retained the original dimensions, but doubled the weight by using heavier materials. Without greatly decreasing handiness, they materially increased power to withstand punishment. This boat weighed 500 pounds.*

Ten years later, when the Geological Survey and the Southern California Edison Company planned a joint expedition through Cataract Canyon, boats of larger dimensions were needed to carry the heavy outfits. Still retaining the lines of the Galloway-Stone original, 18-foot craft were built, with proportionate increase of depth and beam. These weighed close to 800 pounds and must have had not far from double the cargo capacity of the early prototype.

The fleet assembled for our Grand Canyon expedition consisted of three of these 18-foot boats and a lighter one of slightly different lines having a length of 16 feet.

One of the many interesting things that the coming voyage was expected to reveal was as to whether in the building of this comparatively heavy cargo- and passenger-carrying boat, there had been too great a departure from the original Galloway-Stone craft of extreme lightness and handiness. The latter weighed 243 pounds and was built to carry a comparatively light load and one man—its oarsman. The boats we were about to use were more than three times as heavy as this, carried at least twice the weight of cargo, and were expected to find places for three men; that is to say, there had been an increase of upward of 500 per

* See "Experiences in the Grand Canyon," by Ellsworth and Emery Kolb, in the NATIONAL GEOGRAPHIC MAGAZINE for August, 1914.

Photograph by Lewis R. Freeman

A PLACID STRETCH OF THE COLORADO RIVER NEAR THE HEAD OF MARBLE CANYON

"Ahead the portal of Marble Canyon was the beginning of a black gash cleaving the plateau like the wound from a giant's kriss" (see text, page 485).

cent in weight without any increase of power.

The latest boat had still to be handled by a single man. Whether the demand was too great—whether too much handiness had been sacrificed for carrying capacity and strength — remained to be seen. The Powell and Stanton boats, it is true, were larger and heavier than these of ours, but they were manned by a minimum of three men each—two rowers and a steersman.

Thirteen days were spent at Lees Ferry getting ready for the voyage. Recoppered, recaulked, and repainted, the used boats appeared tight and thoroughly serviceable. A folding canvas boat, to be used by the rodman and to have below rapids, in the event of trouble, seemed to promise real usefulness—as long as it lasted.

Satisfactory waterproof bags and boxes had been made only after months of trials and experiments, during which all of the tubs and sinks and basins in the Geological Survey wing of the Department of Interior building in Washington had served their turns as testing tanks.

The best protection for bedding, duffel

Photograph by E. C. Kolb

SHEER WALLS IN MARBLE CANYON

The rate at which this canyon burrows its way into the earth never fails to astonish the traveler entering it for the first time. Twenty miles below its head, the walls are 2,000 feet above the river, nine-tenths being due to the rise of the plateau and one-tenth to the descent of the stream (see page 485).

Photograph by E. C. La Rue

THE "MARBLE" BEACHED FOR REPAIRS AFTER RUNNING BADGER CREEK RAPID

The bottom of the path-finding boat was punctured in the first rapid negotiated by the expedition, but the damage was quickly repaired (see text, pages 491 and 493).

and provisions such as flour, sugar and dried fruit, proved to be an inner sack of rubber, covered with an outer one of waterproofed canvas with a double tie.

An attempt to make water-tight instrument and camera boxes from galvanized iron was a failure, principally owing to the tendency of the metal to bend under pressure. Further experimentation resulted in a highly serviceable wooden box, the cover of which was held down upon a rubber gasket by brass catches.

WE CARRY A RADIO SET AND SEVERAL TYPES OF LIFE PRESERVERS

Of the several kinds of life preservers provided, the old cork type was the only one giving any great amount of buoyancy. A type of stuffed jacket and an inflatable rubber girdle that just about kept a man up in quiet water were tried and the two worn in combination lifted him higher, but were scarcely less bulky than cork. Real freedom for rowing action in a life preserver was a problem which would have to be worked out by experience. Something of the kind had to be worn in every bad rapid; that was the leader's order and a very sensible one.

A receiving radio set had been included in the outfit for two reasons: on the chance that it might bring us warning in the event of a flood descending from above and as a possible source of entertainment. The publication of an article in a prominent radio magazine the week we left Flagstaff provided a new line of interest. In this it was stated quite definitely that it was impossible to receive radio messages in any deep, sheer-walled natural depression. As we were about to enter the deepest gorge of this kind in the world, an unparalleled opportunity would be offered to put this theory to the test.

In spite of the interference of daily thunderstorms and terrific heat radiation from the Painted Desert, our set gave good service from the day it was set up at Lees Ferry. The broadcastings of KHJ of a Los Angeles newspaper always came in most clearly, but on several occasions we had stations as far east as Chicago. We had only four earpieces, but an amplifier improvised from a baking

Photograph by E. C. La Rue

THE "BOULDER" BEING SKIDDED OVER THE ROCKS AT THE HEAD OF SOAP CREEK RAPID
(SEE TEXT, PAGE 496)

Photograph by E. C. Kolb

THE "GRAND" AFTER PORTAGE AT SOAP CREEK RAPID
Left to right: Moore, Birdseye, Blake, Lint, and Burchard.

Photograph by E. C. Kolb

THE "BOULDER" RUNNING THE LOWER PART OF SOAP CREEK RAPID

One man of the Stanton surveying party of 1889 lost his life in this turbulent stretch of water (see text, page 496).

powder can and a tin funnel offered entertainment for a wider audience on occasion.

THE BOATS NAMED AND ASSIGNED

Nomenclature of the boats was a serious question, but after much discussion we decided to base it upon Colorado River canyons—gorges which we were to touch or pass through on the voyage. The new boat (see text, page 473, and illustration, page 472) was called *Grand*, the other two 18-footers *Glen* and *Marble*, and the 16-footer *Boulder*. The canvas boat received the name of *Mojave*.

To the *Glen* was allotted the duty of carrying the cooking outfit. Blake was to be its boatman and the cook its passenger. The *Boulder* was designated as survey-boat, to be handled by Lint, with Birdseye and Burchard as passengers.

The *Grand* was given to me to handle, with Moore and La Rue as passengers. Besides geology and hydraulics, we were to specialize on pictures. La Rue had a small moving-picture machine and two or three ordinary cameras. I had two cameras, to be used where they did not interfere with my boating work.

Kolb, with the *Marble*, had no passenger at the outset. Dodge was to carry the rod in the *Mojave*.

Of the four regular boatmen, Lint, Kolb, and Blake had put in several seasons of work in the Galloway-Stone boats; with some little previous rough-water experience, I pulled an oar in this type of boat for the first time. Dodge rowed well and was still more at home in the water.

Of the engineers, Birdseye, Moore, and La Rue had done some rowing. Both the leader and the geologist had good natural water-sense and took to the river like ducks. Before the voyage was over either would have qualified for a boatman's job had the occasion arisen.

LAST-MINUTE SUPPLIES

A line on the multifarious needs of an expedition such as that upon which we were about to embark may be gained from a list of last-minute purchases which Roger Birdseye, our land manager, drove

out to make in Flagstaff the final week in July. Although six months of study and thought had been put into the outfit, which was supposed to be complete when we came in a fortnight previously, there were about a hundred additional items that seemed desirable. Another formidable list was made up of things to be brought down to meet us at the foot of the Hance Rapid, below the mouth of the Little Colorado (see text, page 498).

The ability to secure necessities of every description in a comparatively short time was the outstanding advantage that this expedition had over those of earlier Colorado Canyon navigators. Powell's first party was able to replenish supplies only once after the start from Green River, Wyoming, and the second party only three or four times.

As the time for starting approached, it became evident that we must expect to cope with unseasonably high water. The river, which Mr. Cockroft, the Government hydrographer, reported as flowing from 30,000 to 35,000 second-feet during our first week at the Ferry, was still holding up around 25,000 second-feet at the end of the month—well above the normal for that time of year.

Photograph by E. C. La Rue

A DOWNSTREAM VIEW OF MARBLE CANYON: AT THE LEFT IS A BIG CAVE (SEE TEXT, PAGE 513)

Just how this condition would affect navigation was problematical. Generally speaking, extreme low water is considered safest, especially where there is much lining or portage to be done. With our heavy boats and loads, however, it seemed quite possible that well-filled gorges and deeply covered rocks might be desirable. This, like a number of other things, remained to be seen.

We had been provided with a manual of navigational information which had been compiled by Herman Stabler, Chief of Land Classification Branch of the Geological Survey, from a study of all available reports and accounts of previous voyages. This manual gave mileage, estimated falls of rapids, and data as to how other voyageurs had surmounted difficulties.

READY FOR THE START

By far the most complete record proved to be that kept by Frederick Dellenbaugh, of the second Powell expedition; but as this ended at the mouth of the Kanab, only about half of the Grand Canyon was covered. Excerpts from Powell's report of his first voyage were also included in Mr. Stabler's interesting record, as well

Photograph by Lewis R. Freeman

THE "GLEN" IN SOAP CREEK RAPID

H. E. Blake, in the cockpit, has about his neck an inflated rubber life preserver, worn by order of the leader while negotiating every dangerous rapid.

as notes from those of Stanton and the Kolb Brothers.

After packing and shaking down outfit most of July 31, we were ready for an early start on the morning of August 1.

The mountainous piles of supplies on the bank seemed sufficient to tax the capacity of a deep-seagoing freighter — enough to swamp our diminutive shallops many times over; but the holds of the latter admitted an astonishing amount of cargo, and we finally took everything needed without having to remove the safety air tanks.

With their full loads, all four boats were well down in the water, especially the *Grand* and the *Boulder,* which were carrying two passengers each. My boat seemed strangely heavy and slow in responding to the oars, as we swung out into the current, but that was partly from the contrast to the way it had responded when empty.

It was a morning of bright sunshine on the river, but above the gay slash of the Vermilion Cliffs piles of snowy cumuli were gathering for the afternoon thunderstorm. To the south the terra-cotta walls of the Echo Cliffs were etched with the cross-lights of the early sun. Astern the yawning mouth of Glen Canyon was a pool of purple shadow; ahead the portal of Marble Canyon was the beginning of a black gash cleaving the plateau like the wound from a giant's kriss.

"Out of the dark and into the dark,
With only a sleep between."

How well the lines described Powell's overnight camp at the mouth of the Paria! Even a boat that was showing an annoying tendency to work in toward the cliff below the old Mormon dugway could not quite take my mind off the pioneer canyon navigator at that moment. He had found easy going in the long quiet reaches of Glen Canyon, but ahead was the Unknown in the most sinister aspect it had yet assumed. He was too good a geologist not to read the warning in the changing formations, for he wrote:

"With some feeling of anxiety we enter a new cañon this morning. We have learned to closely observe the texture of the rock. In softer strata we have a quiet river; in harder, we find rapids and falls. Below us are the limestones and hard sandstones we found in Cataract Cañon. This bodes toil and danger."

To none of the later parties, including our own, was the menace of the canyons ahead what they were to Powell. We had the same rapids to face, to be sure, but their positions had been fairly well charted, and we knew that, in one way or another, they could be passed without prohibitory risk. We had ample food supplies and repairs, with replenishment always waiting a few miles ahead. Powell ran the whole length of the canyons of the Colorado with the shadow of the Unknown just ahead, and all of the Grand Canyon with the specter of Starvation clutching with grisly hand at the steering oar.

A FAREWELL CAKE

As we dropped down past the old stone houses of the hydrographer's station, Cockroft paddled out in his canoe and delivered a parting gift from his wife in the form of a cake. It bore some sort of a farewell message in white frosting on pink, all pegged on with toothpicks to keep it from slipping when it melted in the mounting heat.

Just below the dugway, where the first outcropping patch of limestone marked the beginning of Marble Canyon, Birdseye and Burchard landed and began work by tying the river line into the completed survey from Glen Canyon.

The rate at which Marble Canyon burrows its way into the bowels of the earth never fails to astonish the traveler entering it for the first time. The uprearing of the walls is due both to the rapid rise of the sundered plateau and to the fall of the river; mostly to the former. The river drops at the rate of about 10 feet to the mile, or 200 feet in 20 miles. At that distance from the head of the canyon the walls are 2,000 feet above the river, having risen at the average rate of 100 feet to the mile. Thus it would appear that, in this section of Marble Canyon, nine-tenths of the height of the walls is due to the rise of the plateau and one-tenth to the descent of the river.

At three miles from the Paria we stopped to look over the first riffle of any size in the canyon. Some rocks showed at the surface near the head on the right, but were easily avoidable. The boats

Photograph by Lewis R. Freeman

MYSTERY ENVELOPS THE FATE OF THE TRAPPERS WHO LEFT THIS EQUIPMENT

The cave in which these objects were found by the Grand Canyon Expedition is below high water mark, so that lighter articles must have been swept away. It is surmised that the owners' boat was lost in the rough water immediately below, now christened "Cave Rapid" (see text, page 510).

THE CANVAS BOAT "MOJAVE," WRECKED IN CAVE RAPID (SEE TEXT, PAGE 513)

Only one oarlock and some kindling wood were salvaged after the frail craft smashed on the rocks.

Photographs by E. C. La Rue

A HARD BERTH

The water has carved oddly shaped recesses in the limestone which forms the wall one mile below the mouth of the Little Colorado River.

Photograph by E. C. La Rue

CLIFF DWELLINGS 600 FEET ABOVE THE RIVER, ON THE NORTH WALL NEAR NANCOWEAP CREEK, BELOW THE MOUTH OF THE LITTLE COLORADO

Photograph by E. C. Kolb

IN THE "MARBLE" IN KWAGUNT RAPID

The 1923 party encountered rougher water here than had any preceding expedition, due, in all probability, to an accession of boulders brought down the Kwagunt on the crest of some recent cloud-burst.

Photograph by E. C. Kolb

THE "GRAND" IN RAPIDS 11 MILES ABOVE VASEY'S PARADISE

Such a vast amount of sediment is carried down by the swift current of the Colorado that the rapids never froth white, but present uptossed ruffles of gray foam which when photographed resemble churned lava.

bobbed through at a lively rate, but without taking much water. We tied up for lunch at a so-called bridge site a mile farther down the river—a narrow section with abrupt walls nearly 500 feet in height on either side.

The bridge plan is an Arizona project for linking the two sections of that State now almost inseparably divided by the Grand Canyon. If the structure is ever built it will have no rival in height for a long time. It will be approximately 600 feet long and will be 500 feet above the water.

A THUNDERSTORM BETWEEN ROCKY WALLS

After running another small riffle, a half-mile pull in quiet water brought us in sound of a heavy roar which we knew to be that of Badger Creek Rapid. We came in sight of it 20 minutes later—an uptossed ruffle of gray foam (the Colorado's muddy current never froths white) beyond which the river dropped completely from sight.

Pulling in cautiously, we landed in a quiet eddy behind three large rocks, where a clean, white sandbar offered an attractive camp. We were just starting down to look over the rapids when a gathering thunderstorm broke in a heavy squall and forced us to seek shelter under projecting rocks. Thunder is never so impressive as between sheer rocky walls; likewise an incipient cloud-burst, especially when it puts down enough water to turn the opposing canyon rims into twin Niagaras.

One soon learns to seek his shelter away from low drainage depressions or under those parts of the cliffs stained black by transient storm-fed waterfalls. A deep undercut cave in the sandstone or limestone is the best shelter—provided it has no back entrance.

Powell had portaged boats and outfit around Badger Creek Rapid on both his first and second expeditions. Stanton had done likewise, both with the Brown party boats and those of his own expedition. The Kolbs had run with both their boats, but had struck a number of rocks in the course of a very bumpy passage.

Photograph by E. C. Kolb

LA RUE, MOORE, AND FREEMAN ON BOULDER ISLAND AT VASEY'S PARADISE

Delicately rather than brilliantly colored, the subdued pinks and yellows and browns make the cliffs below Vasey's Paradise unrivaled in the whole Grand Canyon, save possibly by those in the vicinity of the mouth of Havasu Creek (see text, page 513).

We were hoping to run if the stage was at all favorable.

Nine-tenths or more of the rapids in the Colorado River canyons are formed by dams of boulders washed out of side creeks. If the section where this occurs is a narrow one, the barrier will extend all the way across, usually making the resultant rapid steep and violent. In a broader section there may be room for the river to swing round the outer curve of the boulder fan with a comparatively unobstructed channel.

A FORBIDDING PROSPECT

At Badger Creek Rapid the dam thrown out from the canyon of that name has been reinforced and heightened by the cloud-burst discharge of a small unnamed canyon immediately opposite.

The rapid appeared decidedly rough as we looked it over, where it rumbled and tumbled in the deepening shadows of the cliffy walls above. From the right bank it was difficult to fix upon a course where a boat could be certain of avoiding rocks all the way through.

From an elevated vantage on the left-hand cliff the passage was more chartable. For two-thirds of the way across from the right bank the fall over the boulder barrier was too abrupt and too broken to give a boat a fighting chance of surviving a run. Then a deeper V of hard-running water cut through before the impassable boulder wall resumed again.

The channel through the V was closely beset by rocks from the very head, while half way to the foot of the rapid it led directly over a shallowly submerged boulder into a hole so deep that the bottom could not be plumbed with the eye. This would have to be avoided after dropping through the channel at the brink of the fall.

There were several places where it was possible for a boat to get into trouble; but with reasonably good luck and careful handling there did not appear enough risk to warrant resorting to the only other alternative — portaging boats and loads over 200 yards of slippery boulders.

PREPARATIONS FOR THE FIRST RUN OF A RAPID

The leader signified that he was willing to risk the boats if the boatmen were game enough to take a chance at a wetting. Half the battle in running a rough and rocky rapid is to put the boat into the head at the most favorable place. In many instances that—and keeping the boat stern-on to the current and waves—is almost all that is necessary.

The simplest way to test the set of the current is to toss driftwood in above and watch its course through the broken water. When this was tried as a preliminary to running, the following morning, the drift sent down the V at the head carried straight into the deep hole part way down to the foot. This meant that sharp pulling would be necessary to keep a boat from plunging into what appeared to be a place of real danger.

The preparations for this first run were made with considerable care. All cameras, instruments, and the radio set were kept out and carried to the foot of the rapid. The remainder of the loads was carefully trimmed before screwing down the hatches. Oarlocks were wired in to prevent the loss of oars in case of an upset, and baling buckets were secured on short lengths of line.

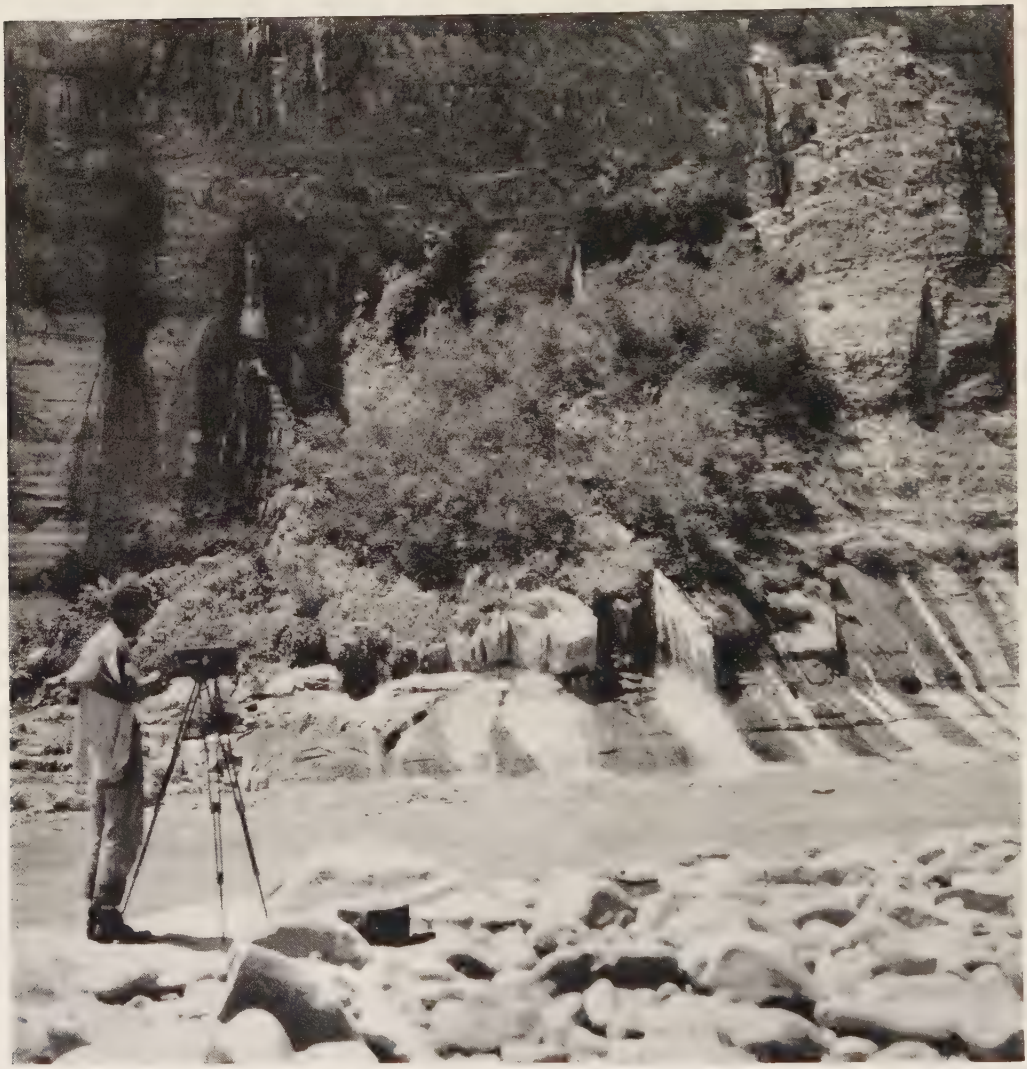
Nothing was left loose in the cockpits save the boatmen. The canvas boat was carried to the foot of the rapid and launched, to be ready in case of need.

KOLB MAKES THE FIRST RUN

The opening run was far from auspicious. Kolb dropped into the V just as planned, so far as avoiding the big boulder on the left was concerned. He missed this by half an oar's length, but failed to reckon with a slightly more deeply submerged rock just below. The *Marble* was not upset or hung up by the obstruction, but the blow dealt the bottom threw it partly out of control and prevented effective pulling. Swung half sidewise, it drifted over a rounded wave and dropped into the deep hole!

Almost disappearing in a cloud of spray, the boat reappeared an instant later, partly filled but still riding buoyantly. Too far to the left to make the foot of the rapid on the right where the cameras and instruments had been portaged, Kolb pulled in and landed in an eddy against the opposite bank (see page 480).

Lint, following in the *Boulder,* hit the



Photograph by Lewis R. Freeman

LA RUE TAKING A PANORAMA AT VASEY'S PARADISE (SEE TEXT, PAGE 513)

"A patch of green shot with gushing jets of clear water."

V just right and pulled away from the rocks with plenty to spare.

In drifting down, stern first, I took the *Grand* a few feet too far to the left and was carried back upstream along the bank. Circling round and pulling out of the back water, I swung to the middle of the current and dropped down to the brink of the fall again. The abruptness of the descent made the opening impossible to see until one was almost upon it, and then only by standing up.

Once the V began to open up, I sat down, pulled hard against the current setting toward the jutting rocks, and slid over the top.

The jolt of the first wave was a solid one and there was real weight in the piece of it that came bounding over the stern against my chest. Missing a stroke or two before recovering, I let the *Grand* swing quartering over the next comber, but had no trouble in bringing its head back upstream again and pulling well clear of the bad hole.

Blake, running last, was drawn somewhat to the right of the V, dropping down into a broken wave that swept com-

Photograph by Lewis R. Freeman

SITE OF A TWO DAYS' CAMP: A SANDBAR IN MARBLE CANYON

Here the party spent August 10th, the day set aside for the observance of the funeral of President Harding, news of whose death had been received by radio a few minutes after the tragic event occurred (see text, page 497).

pletely over the *Glen*, hiding it from sight for all of a second or two. It was in rough water for the next hundred feet, and then came out under good control.

KOLB'S BOAT PUNCTURED

When Kolb came to examine his boat he found that the after hold was several inches deep in water. Investigation showed that the bottom had been punctured near the bulkhead, doubtless by the rock hit at the head of the rapid. Sugar, salt, oatmeal, and other things not in rubber sacks at the moment were wet, and considerable water had penetrated to the supposedly water-tight map cases. Fortunately, none of the sheets of the new survey had yet been transferred to the cases.

Powell had estimated the fall of Badger Creek Rapid to be 18 feet, while the Kolbs put it at 20. Burchard, of our party, found it to be 13.

Ours was the first voyage on which the fall of the rapids of the lower Colorado canyons was measured with precise instruments. From beginning to end, the earlier estimates were found to be far too

Photograph by E. C. La Rue

UPSTREAM VIEW OF THE GRAND CANYON FROM A POINT FOUR MILES BELOW THE LITTLE COLORADO RIVER

liberal. A guess at the fall of a rapid is almost invariably too high. The fall of a river in a given distance varies slightly between high and low water, it is true, but not enough to account for the difference between the actual descents and the estimates of earlier voyageurs. Moreover, both of Powell's voyages were made at approximately the same water stage as was that of last summer's survey.

The walls of the canyon, which were 730 feet above the river at Badger Creek, increased steadily in height as we proceeded, with an ever broader streak of maroon-chocolate Hermit shale showing as we penetrated deeper into the gorge.

About two miles below Badger Creek we came to a striking monument of dolomite in the middle of the river. It looked solid enough to be an outcropping of bedrock, but must have fallen from one of the higher formations. As it is not mentioned by previous navigators, and as the fracture from which it appears to have come has not weathered greatly, it is probably of very recent origin.

Upon reaching a long, straight stretch of canyon running east and west, we landed to photograph a great rectangular cliff which towered against the sky-line, revealing breaks at both ends, neither of which was positively identifiable as the course of the river.

A PORTAGE AT FATAL SOAP CREEK RAPID

A heavy roar became audible as we neared the bend, indicating the presence of the major rapid below Soap Creek—a mile or two nearer to Badger Creek than was shown by existing maps.

An extensive fan of white boulders — limestone — completed the identification of a rapid with one of the worst reputations on the Colorado.

Landing, we picked a camp site on the right bank 100 yards above the break of the fall.

Photograph by E. C. La Rue

DOWNSTREAM VIEW OF GRAND CANYON FROM THE LEFT BANK AT A POINT 88 MILES BELOW THE LITTLE COLORADO

Navigation was comparatively easy in this stretch of the river, and from the mouth of the Little Colorado to the mouth of Havasu Creek (through Grand Canyon National Park), the expedition was usually three or four days ahead of schedule, making from five to ten miles a day compared with three or four in Marble Canyon (see text, page 520).

Photograph by Lewis R. Freeman

SPRUCING UP: DODGE CLIPPING KOLB'S BEARD

There is ample room to portage on the boulders to the right of Soap Creek Rapid, and both Powell expeditions had avoided the savage tumble of rough water in that way.

The railroad surveying party of 1889 also portaged its boats round the main fall, but shortly after launching them in the swirling waters below an upset occurred in which Brown, the president of the company, was drowned. Stanton did not attempt to run the main rapid when he came along in 1890, and Ellsworth Kolb in trying to do so suffered successive upsets with two boats. This sinister record has given Soap Creek Rapid a bad name.

At first sight, while plainly of a greater and more violent fall than that of Badger Creek, Soap Creek Rapid looks no more dangerous to run. This is probably because the entering V is more clearly defined than in the rapid above and leaves but one course open; also due to the fact that the boulders under the great waves at the head are deeply submerged, except at extreme low water.

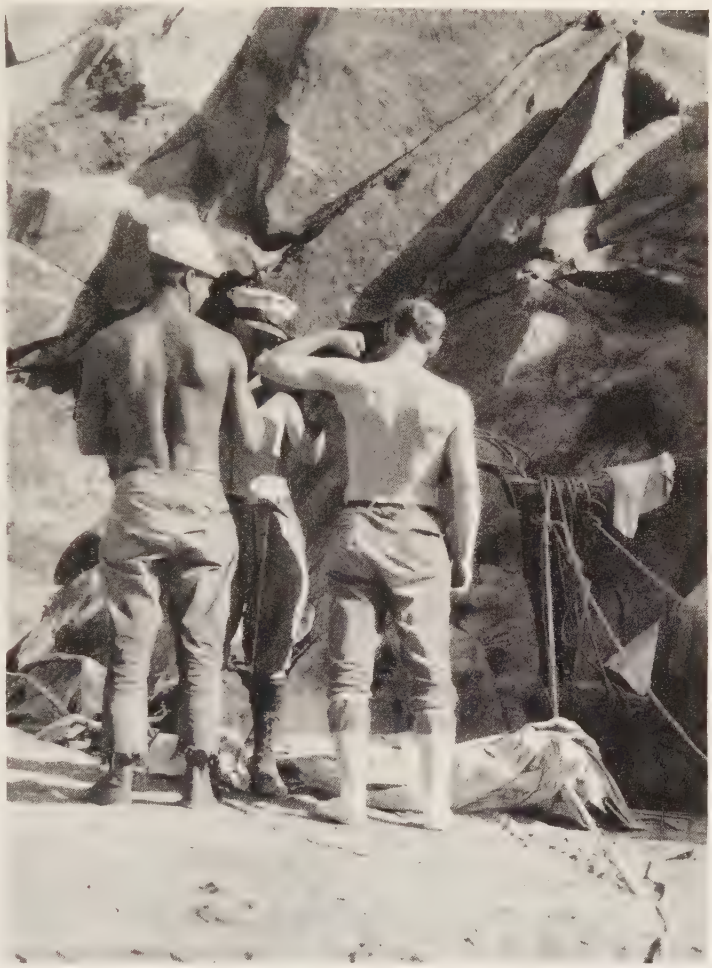
We loaded up in the expectation of running the following morning, but at the last moment Kolb returned from a trip across the river to announce that he considered it too risky; that he believed a boat would be almost certain to upset in one of the first two waves, and after that to drive upon rocks not visible to us from the right bank.

There was some disappointment at missing the chance to attempt what might have been the first successful run of this notorious rapid, but there would have been no point in taking undue risks with an outfit like ours, especially so early in the voyage.

The portage was a short one and the method of effecting it the same in the case of each boat. *Glen,* the cook-boat, was the first to go. It was taken down 200 feet under oars, lined another 100 feet farther, and unloaded. It was then lined empty 50 feet more to the head of the portage. This was across large boulders, over and between which large logs were laid at frequent intervals to prevent the sides of the boats from being crushed in as they were slid down. It was heavy work, yet not so punishing as it would

have been with fewer men available (see illustrations, pages 481 and 482).

The boat was then lowered over a five-foot waterfall to a quiet pool at the end of the portage. Here it was launched and reloaded. It was then backed out of a sort of natural portal between two large rocks, and the rapid was entered on the right, just below the two big waves which had been avoided. The next 200 yards comprised a rough but not dangerous run. Then the boat was pulled into an eddy to a beach along the right bank. The *Grand* was brought down while dinner was cooking, and the two remaining boats in the afternoon, after which there was still time for a cooling swim and a rest before supper.



Photograph by E. C. Kolb

A STUDY IN TAN AND WHITE

Moore, during a noonday halt, is measuring the arms of Lint, browned by exposure, and Stabler, who had just joined the expedition.

A TRAGIC RADIO MESSAGE

Radio had come in strongly at Badger Creek, but it remained for the 1,000-feet-deep section at Soap Creek to furnish conclusive proof of the fallacy of the theory that so profound a natural depression would prevent radio communication with the outside world. Station KHJ had warned us the previous night that it was planning to broadcast special messages to us on the evening of August 2. That was the night of our arrival at Soap Creek.

In preparation for the gala occasion, the aërial was carefully set up, with one end high on the side of a cliff, and orientated on Los Angeles. KHJ came in strong promptly at 9 o'clock, Mountain time, with little interference either from static or from the crashing roar of the near-by rapid. The lightning of distant thunderstorms was jazzing up the purple wedge of sky between the up-river cliffs, but, strangely enough, with scarcely any reaction on the instrument.

Baseball scores had come in and the daily grist of news was halfway through, when there came a sudden break, followed by a brief space of charged silence.

When the announcer resumed it was to state with deep emotion that news had just been received of the death of President Harding in San Francisco. This word was winged a dozen times or more during the next hour, once directly

Photograph by Lewis R. Freeman

PACKING UP FOR PORTAGE AT THE HEAD OF HANCE RAPID (SEE TEXT, PAGE 520)

Photograph by E. C. La Rue

RADIO MESSAGES CAME IN CLEAR AT ALL POINTS IN THE GRAND CANYON WHEN THE OUTFIT WAS SET UP

H. Stabler and C. H. Birdseye are "listening in" at Tapeats Creek. At El Tovar the leader of the expedition sent a telegram to Washington announcing that the party was safe; two hours later, in the depths of the canyon, he heard by radio his own message, as it was broadcast to the country.

THE PAINTED DESERT AND HOPI LAND IN THE DISTANCE

The view is from Navajo Point, on the edge of the Coconino Plateau (see map, page 474).

addressed to "the engineers braving the rapids of the Colorado." We had received our special message, though not the one expected.

RADIO WORKED PERFECTLY AT DEPTH OF A MILE

The first news of the President's death was received at about 8.15, Pacific time—perhaps forty-five minutes after the tragic event. Not one in ten thousand of the city dwellers of the country could have had the news at so early a moment. Colonel Birdseye announced at once that a day of rest would be taken by the expedition out of respect to the memory of the President. The exact date would be decided later, when the day of the funeral was learned over the radio.

Almost unconsciously the radio had come to be accepted as a regularly functioning unit of the outfit. Although occasionally affected by heat and local electrical storms, it continued to work just as well when the gorge of the Grand Canyon had deepened to a mile as it did the night it brought us the momentous message in the camp at Soap Creek Rapid. That it failed to pick up the many warnings of impending flood that were broadcast to us was not the fault of the outfit. It was enjoying a temporary rest while fresh batteries were being sent in (see page 524).

The fall of Soap Creek Rapid was found to be 18 feet. Earlier explorers had put it at 25, with waves 12 feet high.

Photograph by E. C. La Rue

LOOKING UP LOWER GRANITE GORGE FROM THE MOUTH OF BRIGHT ANGEL CREEK, SHOWING BRIGHT ANGEL SUSPENSION BRIDGE

For an account of the construction of this bridge, which is 500 feet long and hangs 60 feet above the river in normal flow and 13 feet above the highest known water mark, see "The Grand Canyon Bridge," by Harriet Chalmers Adams, in THE GEOGRAPHIC for June, 1921.

The latter estimate is conservative, especially regarding the two big waves at the head of the first steep drop.

The waves of rapids are very difficult to measure. Estimates of the height of many we ran or narrowly avoided varied considerably, even among the engineers of the party.

For several miles below Soap Creek there is no water through which a well-handled open boat cannot be run without serious danger. The fact that an upset was responsible for the death of Brown, president of the company planning to build a railway through the Grand Canyon, is proof of the inadequate boats of his party. Stanton's perseverance with so poor an outfit, after the death of Brown, is one of the finest examples of fortitude in Colorado River history.

At noon on the 4th we halted for lunch on a shelf 100 yards above the head of a long and fairly rough rapid, the walls on both sides of which were so sheer that there was no chance of working along to reconnoiter. From the most favorable vantage point attainable, the upper section appeared to be readily runnable; a second riffle, disappearing around a bend below, could only be guessed at.

To Powell, on his first voyage, the place was calculated to awaken serious apprehension, and he ran it only after working his boats down along the wall to the head by a very ingenious and intricate piece of lining. In our case, knowing the rapid had been run a number of times without trouble, there was little to give pause.

Photograph by E. C La Rue

UPSTREAM VIEW OF A RAPID FIVE MILES ABOVE THE MOUTH OF TAPEATS CREEK

It was in this rapid that the author's boat, the *Grand* came into collision with a boulder. The blow was so violent that he imagined his craft had "actually bounced back upstream from the impact." An incipient leak was effectually closed with a patch of canvas and some white lead.

Photograph by E. C. La Rue

UPSTREAM VIEW OF THE GRAND CANYON FROM THE LEFT BANK, AT THE MOUTH OF BOUCHER CREEK, ABOUT NINE MILES BELOW BRIGHT ANGEL CREEK

The *Grand* was the last boat to start. La Rue, who was casting off the painter, slipped on the smooth rock and all but let us swing off into the swift current without him. As there was no chance of going back, either by land or river, we never quite worked out how the party would have recovered its hydraulic engineer had he marooned himself.

The canyon displayed points of rare beauty, with the Supai sandstone rising higher and higher from the water, and the Kaibab limestone and Hermit shale beginning to form a secondary wall behind.

Many caves had been formed by the undercutting of the cliffs. Pulling back into one of these to await the instrument, we lounged for half an hour in the cool depths, singing lustily to while away the time. Amazingly mellow-voiced we all were—thanks to the softening effects of the cavernous echoes.

We ran a rough major rapid just before going into camp that night, and a second immediately after lunch the following day. Both were much like Soap Creek in the way they rolled down steep pitches to undercut curving cliffs of the left bank.

All previous parties, including the Kolbs, had portaged at least one boat at the head of the latter rapid, which was somewhat more menacing from the fact that a second riffle began not far below to disappear in a tumble of broken water around the next bend. I had my first experience with the solidity of the bottom of the Colorado River at this point.

A heavy sandstorm was blowing out of the side canyon to the right as I drifted down to the head of the rapid, and in pulling against it I worked too far to the right and found the *Grand* dropping upon a bad mess of boulders almost under the bank. Hard

Photograph by Lewis R. Freeman

THE "BOULDER" IN WALTHENBURG CREEK RAPID

Although this rapid has a fall of 13 feet in a very short distance, making it one of the steepest of the Colorado River, it did not prove especially difficult to the Grand Canyon Expedition at the stage of water which the party encountered.

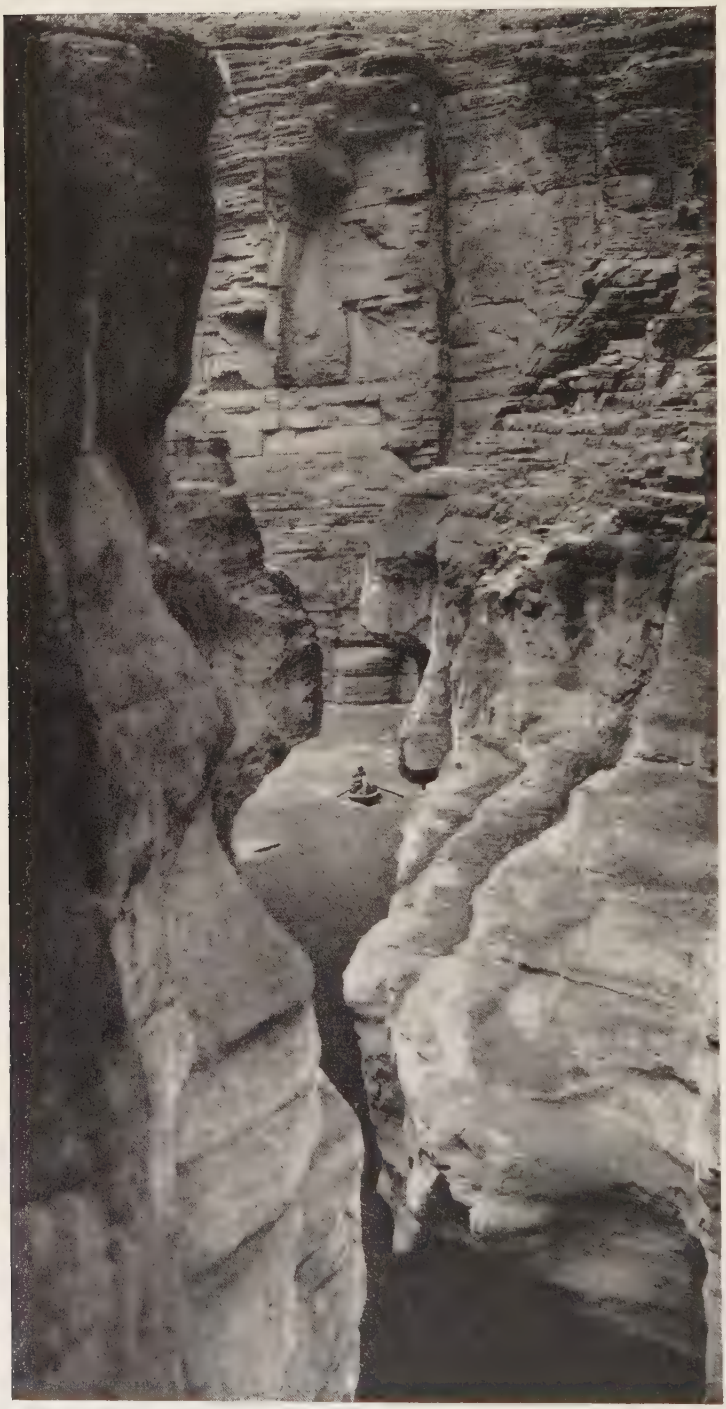
Photograph by Lewis R. Freeman

THE "MARBLE" IN WALTHENBURG RAPID, TWO MILES ABOVE TAPEATS CREEK

Photograph by Lewis R. Freeman

HANDLING THE SURVEYOR'S ROD AT WALTHENBURG RAPID

It was here that the Kolbs, on their photographic expedition of 1914, experienced a serious upset, with considerable damage to one of their boats.



Photograph by E. C. La Rue

DOWNSTREAM VIEW OF HAVASU CREEK, WITH THE COLORADO RIVER IN THE BACKGROUND

Framed between the overhanging walls is the *Boulder*, ready to land for supplies.

pulling did not quite carry me back to the channel, and as a consequence a corner of the stern bumped solidly against a rock, allowing the boat to swing completely round.

The boat drove through the next couple of waves bow on and then slid away from the heavy rollers under good control. Pulling across the current of the tail of the rapid, I beached the boat on the left bank, to find that it had suffered no damage from the collision.

The *Grand* had the driest run through of any of the boats; nevertheless getting in where I did at the head was not creditable, even in the face of a sandstorm.

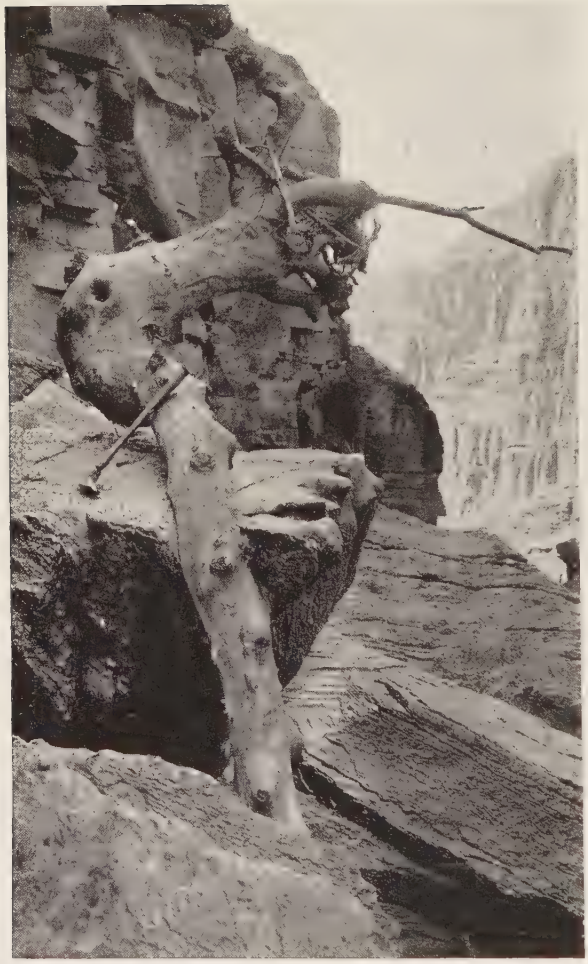
CAMPING ON A STEEP TERRACE

Camp was pitched on a steeply sloping terrace of rocks and sand at the head of a big back-sweeping eddy. The sand was bound and held in place by the roots of salt grass, very fresh and green in appearance. Room for our beds had to be cut with the spade out of the silt and sand. The bank from which mine was sliced had a 60-degree slope to the river.

Moore lay feet-to-feet with me, while the Chief kicked sand impartially on both

A WATERFALL IN HAVASU CANYON: GRAND CANYON NATIONAL PARK

In this deep gorge are several of the most beautiful falls in the world. Their number and beauty led the explorers who first saw them to call the gorge Cataract Canyon, a name by which it is still known upon some maps, but which is officially used now to designate the stretch of the Colorado above Marble Canyon.



Photograph by E. C. La Rue

"WHERE WOOD CUTS STONE"

A willow log six inches in diameter has eaten into a hard limestone boulder, four miles below the mouth of Havasu Creek. The log was not worn, which demonstrates that the water acts as a cushion, protecting the wood, while the silt in the water does the cutting.

of us from his niche above. Radio came in as clearly as ever, in spite of the fact that the rim of the Kaibab now towered more than 2,000 feet above us. There was a Sunday evening concert of real quality over KHJ; also an announcement that the date of President Harding's funeral had been fixed for the 10th.

From a boating standpoint, August 6 was one of the liveliest days of the voyage. Three or four major rapids and a number of riffles were run, in nearly every instance the head of one being in sight from the foot of the preceding. The total distance made was three miles, with a descent of 50 feet. This stretch has probably the heaviest average fall in Marble Canyon.

As the *Grand* approached the second rapid with Moore and La Rue riding, Kolb, who had landed to look it over, signaled me that it was all right to go on through. It was a straight run down the middle, with no chance of hitting rocks—only big water.

The opportunity to see what the boat would do in really heavy waves, where there was no chance of banging it up, was too good to miss. Sooner or later it would be swamped, anyhow, I told myself, and it would be a good plan to find out what weight of water would do it. Unfortunately, I was so confident of riding this particular chute without filling that I did not take the precaution of putting my camera under cover.

SWEPT BY WAVE AFTER WAVE

The middle V rolled over smooth and solid, like the brink of a real cataract, and it was not until we were almost at the upflung comber at the bottom of it that I had an inkling of what we were in for. The *Grand* had an easy rise to the first wave, and went through it without tearing more than a bucketful off the top.

The next was a sidewinder from the right, however, and came banging over the quarter savage and solid. La Rue's writhing anatomy stopped a lot of it, but enough rolled on to fill the cockpit up to the seat. A third wave completed the job and left the gunwales awash. We barged down the rest of the rapid after the fashion of a raft, with wave after wave sweeping us fore and aft.

As the water was warm, there was no particular discomfort. The boat rolled much worse than normally, dipping a gunwale under at every roll; but she was still responsive to the oars and I had no trouble in bringing her into an eddy and

Photograph by Lewis R. Freeman

LA RUE, WITH A CURRENT METER, MEASURES THE FLOW OF A SIDE STREAM

up to the left bank well above the head of the next rapid. After ten minutes of baling, the cockpit was dry again. The water-tight box under the seat in which some of our cameras were kept was as good as its name.

The small camera, which had sloshed around the cockpit for a couple of minutes, was soaked and the film spoiled. Except for that, the experience was a valuable one in giving a line on the boat's capabilities in heavy water. Plainly, a swamping was a matter of no serious moment, provided there were no bad rocks below. To me the incident was distinctly reassuring, though it took some argument to bring my saturated passenger on the after hatch round to the same way of thinking.

The other three boats, with one passenger each, made the run through the rapid without incident, but Dodge, with the canvas boat, capsized in the first wave, dropping out of sight for two or three seconds. Bobbing up again farther down, he appeared to be holding to the overturned boat and working it toward an eddy along the right bank. Lint and I pulled across to him, but he had the canoe against the rocks and was trying to right

Photograph by E. C. La Rue

THE GRAND CANYON ONE AND A HALF MILES ABOVE HAVASU CREEK

This is near the west boundary of the Grand Canyon National Park. Note the "face" in the notch of the canyon wall.

it before we arrived. It was a hard place in which to work on account of the packed driftwood, but a few minutes sufficed to have the *Mojave* in commission again. To Dodge, who was born in Hawaii and half raised in the water, the upset was no more of an incident than his morning bath.

Drifting past an undercut cliff, I noticed for the first time the water-polished limestone which had led Powell to apply the name of Marble Canyon to the gorge which is properly the upper end of the Grand Canyon. This is not a real marble, according to Moore, but it is very hard, takes a beautiful finish, and would undoubtedly make a fine building stone. I passed within oar-length of some brilliant outcroppings of rock crystals, and at one point about 40 feet above the water was the mouth of a cave of considerable depth.

A TRAPPER'S OUTFIT FOUND IN A CAVE

We ran on to a camp at the head of an abrupt and noisy rapid, where the seepage from a steep canyon formed a number of clear springs, while a rising series of hard sand terraces gave good sleeping room. Climbing over the rocks to look at the rapid, we found a trapper's complete outfit half buried in the sand of the floor of a large cave. Traps, cooking utensils, brace and bits, saw, files, awls, coffee mill, and a number of other things were listed and laid out for a photograph (see page 486). The only article of wearing apparel was a rubber boot.

As the cave was below high watermark, it appeared probable that all of the lighter objects had been carried away. We could only conjecture as to the fate of the trapper or trappers. As there is no record of any such party reaching or passing Bright Angel,

Photograph by E. C. La Rue

LOOKING DOWN FERN GLEN CANYON

This canyon joins the Grand Canyon on the right bank, 11 miles below the mouth of Havasu Creek.

Photograph by Lewis R. Freeman

BATHING IN KANAB CREEK

The end-of-the-day plunge was a regular feature of the party's program for many weeks. The water was usually red with mud, but it was "a clean sort of mud" and came off readily under vigorous toweling.

it seemed practically certain that the owner or owners were lost, with their boat, in the rapids below. Indeed, we had a graphic illustration of what may have happened to the trappers' boat while preparing to run the following morning what it had been decided to call "Cave Rapid."

Burchard, Dodge, and Kolb were just starting to line the canvas boat down the right side of the rapid, to have it available below in case of emergency, when, the painter being slacked too quickly, the little craft carried over a rock, filled, and was smashed into a shapeless mass.

An hour's work by the whole party salvaged only one oarlock and some kindling wood from the *Mojave*. We were unable to drag the canvas skin from where the current had wrapped it round a boulder. The little boat had been very useful, but was far from indispensable; its early loss, moreover, had been anticipated (see illustration, page 487).

Dodge and the rod henceforth rode on the *Glen*, while the cook was shifted to the *Marble*.

The four boats ran Cave Rapid without passengers.

We had a pleasant camp that night on a beach between two winding rapids, with the seep from a canyon supplying good drinking water again. Burchard, after completing his surveying, stated that he was inclined to the belief that this camp was in the vicinity of Stanton's Point Retreat, and that the canyon behind it was the one by which he had left the river after the culminating disaster had resulted in the drowning of two members of the Brown party of 1889.

Running several easy riffles, we came, just before noon the next day, to one which disappeared around a bend and was divided by the first midstream boulder bar we had encountered. A brilliant patch of verdure against the side of an amphitheater at the right of the bend recalled the leafy bowers of Glen Canyon. A hundred feet farther down the side another patch of green, shot with gushing jets of clear water, revealed the place as Vasey's Paradise, named by Powell after a botanist associate (see illustration, page 492).

The cliffs below Vasey's Paradise are unrivaled in the whole Grand Canyon series, save possibly by those in the vicinity of the mouth of Havasu Creek. Delicately rather than brilliantly colored, their subdued pinks and yellows and browns throw back to the depths of the gorge a mellow blend of lilac, pearl, and amethyst that has almost the palpable fluency of poured wine.

CANYON WALLS UNRIVALED IN COLOR

Plummets of sunlight alchemized frequent wedges of swirling water to arrowheads of liquid gold, with saffron-bright motes weaving in a saraband on the wall above in the dusky purple shadows of a cave mouth. Quiet, smooth-flowing water gave us opportunity to revel in the veritable symphony of colors undisturbed by navigational worries.

We found cold springs spouting out of the rock at a number of points. Some of the most ambitious of these had built themselves little turreted houses from the mineral salts carried in solution—real miniature shower-baths, with the glint of falling water and the rattle of spray always in evidence as we drifted down past their mist-curtained windows.

Grass and flowers were lush and green within spattering range of the flying drops, and it was no end of a delight to drop in from the scorching sunshine of mid-river, to lounge for a few minutes and perhaps strip for a hasty bath in clear water. When one wears only half a pair of pants, or thereabouts, taking a bath is not a matter of extended preparation.

Farther along this same stretch of canyon we came to a fantastic jumble of windows, gables, turrets, and buttresses for which the name of "Goblins' Castle" would be highly appropriate. It had one small hole looking out to the sky through its cliffy roof, and about midday this must let a beam of sunlight through to dance upon the waves of the riffle that is trying to undermine the limestone foundations of the crazy pile.

Toward the end of the afternoon we landed to explore a large undercut cave or amphitheater beneath the left-hand cliff. The roof rose steadily until it overhung the middle of the river at a height of 200 feet. The floor was a succession of terraces of hard, smooth sand, rising like the seats of a stadium until the

Photograph by E. C. La Rue

EAT, NOT SWAT, THE FLY

This pet lizard, in the cabin of the Geological Survey engineer who measures the discharge of the Colorado at Bright Angel (see illustration, page 500), keeps the insects busy.

highest touched the vault of the limestone roof. Powell was in error in locating this cave above rather than below Vasey's Paradise and his estimate of a seating capacity of 50,000 was liberal (page 483).

THE FIRST DEER ENCOUNTERED

On the 9th we passed the first mesquite trees and sighted the first deer. We tried to corner the latter on a talus for the movie camera, but they were too shifty to make close-ups possible. A doe escaped by swimming the river, part of the distance through a fairly swift riffle.

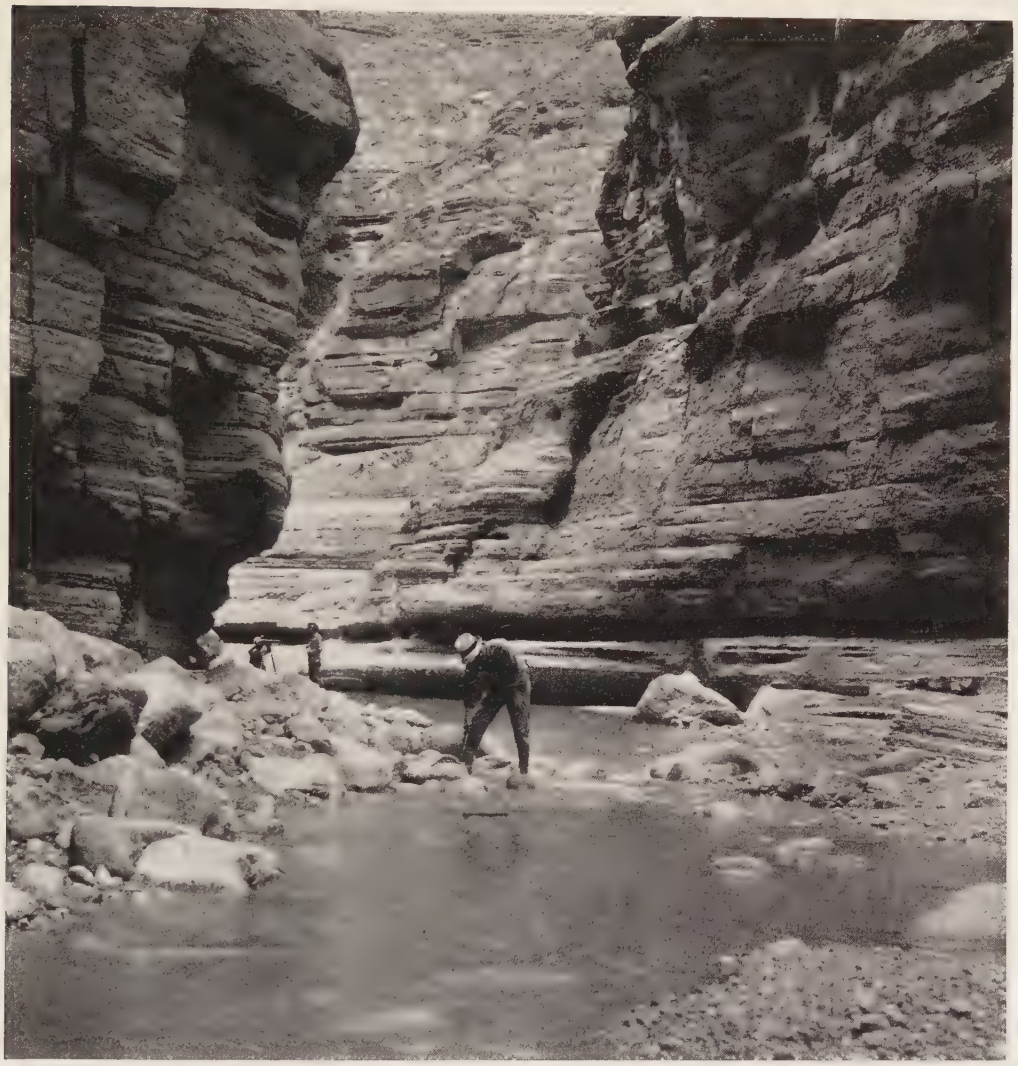
A huge boulder planted squarely in the middle of a short but savage rapid halted us early in the afternoon at a bend which was identified beyond a doubt as Stanton's "Point Hausbrough." As the obstruction ahead plainly needed careful study before passing and as the 10th had been set aside for observance of the memory of the late President, a two-day camp was made on the sandbar opposite the historic landmark (see illustration, page 493).

VIOLENT STORMS

A series of terrific wind squalls swept the river just after we landed, at the height of which water was blown far up the beach where we had begun to pitch camp. The cliffs were masked with clouds of blown sand, and the foam above the water thrown back from the great midstream boulder was carried high up against the leeward walls. Black, swollen thunderheads began gathering in the wake of the squalls and the main storm broke just as supper was over.

There was a lively scramble to keep beds from blowing away. After the wind the rain set in, first in violent squalls, then in a steady downpour. No shelters had been set up. Some of us swathed ourselves in pieces of canvas; others crawled into sleeping-bags and covered up; two crept into the emptied holds of the boats. Probably the best solution was hit upon by those who stacked their stuff under tarpaulins and cavorted about in the warm rain *au naturel*.

Violent storms of this character continued to sweep our camps at frequent intervals until about the middle of September, when the cooler weather of early fall put an end to the seasonal disturbances.



Photograph by Lewis R. Freeman

IN KANAB CANYON—1,800-FOOT LEVEL

Between Kanab Canyon and Havasu Creek the expedition encountered a hitherto-unnamed rapid. In commemoration of the first upset of the trip (in which neither boatman nor boat was injured), it was christened "Upset Rapid" (see text, page 524).

Of the burial of Peter Hausbrough, drowned about ten miles above, Stanton wrote:

"We stood around the grave while one short prayer was offered, and we left him with a shaft of pure marble for his headstone, 700 feet high, with his name cut upon the base; and in honor of his memory we named a magnificent point opposite Point Hausbrough."

Although the grave must have been immediately behind our camp, careful search failed to reveal it, doubtless because the talus at the foot of the cliff had been built up a number of feet in the third of a century which had elapsed since the inscription was carved.

The rock-obstructed rapid which we encountered below this camp is evidently of recent formation. No mention of it is made in the records of any of the earlier voyageurs, and Kolb said he had no recollection of it from his passage of but little more than a decade ago. There appeared to have been a straight, steep chute here in the first place, and this had been

DOWNSTREAM VIEW OF THE GRAND CANYON 2.6 MILES BELOW HAVASU CREEK. THE CANYON OF CATARACT CREEK ENTERS AT THE LEFT

Photographs by E. C. La Rue

TWO MEN AT PLAY 40 MILES BELOW THE MOUTH OF HAVASU CREEK, WHILE WAITING FOR THE ENGINEERS TO COMPLETE A SIDE

Photograph by E. C. La Rue

THE FLOOD AT LAVA FALLS (SEE TEXT, PAGES 524-5)

Unwarned, the party was taken unawares at a point far from favorable—twilight on the brink of the falls

Photograph by E. C. Kolb

LAVA ROCK ISLAND, ABOVE LAVA FALLS

Lava Falls are three and a half days' journey below Havasu Creek (see also text, page 524, and illustration, page 517). The man in the foreground provides the scale.

dammed by a great slide from the right-hand wall—Point Hausbrough. Immediately after the slide the obstruction must have extended from bank to bank, doubtless backing up the water for a considerable distance upstream. Then this broke and carried down the looser débris, leaving only the huge block of limestone planted squarely in the middle of a fierce tumble of broken water.

BOATMAN HURDLES THROUGH THE AIR

Above the rock was a back-thrown wave of water more than 10 feet in height; below it a whirlpool with a depression half as deep as the comber was high. On account of the throw-off of the wave, an actual collision with the rock itself was improbable, if not impossible; the danger was in an upset which would allow the overturned boat and its boatman to be drawn into the whirlpool below, where an uncomfortably rough and protracted stay could hardly be avoided.

After studying the rapid from every angle during our rest day, it was decided to run the right-hand channel. The down-rushing chute appeared to divide almost equally upon the great rock, but there seemed to be a shade greater concentration of current on the side toward Point Hausbrough. We pulled all four boats up the eddy, crossed over, and tied up on the right bank 200 yards above the head of the rapid. Kolb ran bow first, getting as much way on as possible, shooting down the right side of the V and continuing to pull away from the back-curling wave thrown off by the rock. His boat had a hard slap, as did the *Boulder,* which followed, but neither was near to serious trouble.

Blake, running next, evidently failed to get far enough to the right. The *Glen* was driven down against the back-thrown wave side-on, and missed capsizing by a hair. Looking back from above the rapid where I was about to push off with the *Grand,* I saw all the bottom boards of the boat as it was flung on its side; then the flick of a flying oar and the sprawling body of a man silhouetted against the cliff below, as it hurtled through the air. An instant later all had disappeared, and I had to run through myself to learn what had happened.

I eased pulling a bit sooner than was desirable, after dropping over the brink of the chute, and so came in for a harder slap from the wave than there was occasion for. The blow was scarcely less solid than that from actually striking a rock,

and the geyser of tumbling water inflicting it looked even less friendly rearing up above my head than when seen from the bank.

My heavily loaded boat righted quickly, however, and shipped very little water. As it shot past the rock I caught a fleeting glimpse of the hole below out of the tail of my eye. That was another little corner that did not improve with closer acquaintance, especially with the whirlpool showing off what it could do by bumping a captive log of driftwood up against the rock. The cat-and-mouse game looked as if it might have been going on a long time.

The maelstrom seemed to be "whoufing" with glee, as if it could keep up its end of the sport indefinitely, and until it relaxed its hold the only chance the log appeared to have of escaping was through being battered to bits against the boulder. I was glad to pass the outer tips of the indrawing tentacles of the octopus by a comfortable oar's length.

I found the *Glen* right side up in an eddy, with its boatman bailing the cockpit. He confirmed the impression I had received from above: that the force of the blow on the side of the boat had flung him over the gunwale without touching it. Unhurt, he had climbed back aboard after his boat had cleared the whirlpool, replaced a lost oar, and pulled into quiet water.

Photograph by E. C. La Rue

SAVED FROM THE FLOOD

The *Marble*, drawn up 21 feet above the river after the high waters of September 18 had receded (see text, page 530).

Three days more of boating took us to and past the mouth of the Little Colorado, which showed signs of having been in flood and was still flowing an unseasonably high stream of vile-smelling mud.

The main stream was never quite as pleasant bathing after receiving this sewerlike discharge, the rank, offensive smell of which we were destined to experience on one or two later occasions.

The survey showed the length of Marble Canyon to be slightly more than 61 miles, and the elevation of the mouth of the Little Colorado as 2,718 feet. Dellenbaugh had estimated Marble Canyon to be 65 miles long. This discrepancy is not great, considering the conditions under which the Powell expeditions made their calculations.

ENTERING GRAND CANYON NATIONAL PARK

There was nothing at the mouth of the Little Colorado resembling the great whirlpool located there by James White in his lurid account of a raft voyage through the Grand Canyon in 1867, two years before Powell.

Nine miles above the mouth of the Lit-

Photograph by E. C. La Rue

ALL THE COMFORTS OF THE CANYON

Moore enjoying life while activities are suspended for three days, until the flood waters subside (see text, page 530).

tle Colorado we entered the Grand Canyon National Park. As the several sheets covering the course of the Colorado through the National Park are rated as perhaps the finest examples of topographical mapping in existence,* the work of the river party was greatly simplified for most of the next 100 miles.

There was no longer need to survey side canyons, while the amount of topographical work on the main river was materially reduced. This left the carrying of the river line as the principal work of the topographic engineers of the expedition, greatly accelerating our rate of progress.

Where three or four miles was a good average day's work in Marble Canyon, from five to ten could be covered through the National Park. We were usually three or four days ahead of schedule all the way from the Little Colorado to the mouth of Havasu Creek.

There is swift water and a heavy fall to the river all the way from the mouth of the Little Colorado to the head of the Granite Gorge, but only three or four major rapids. The last of these is the Hance, at the foot of the trail of that name.

We had lively boating in a storm-swollen river all the way down this 15-mile stretch, but no serious mishaps, and reached the foot of the old and long-disused Hance Trail in the forenoon of the 16th, four days ahead of the time our pack-train had been ordered to come down with fresh supplies. In the interval we sent out to El Tovar for new and stronger oarlocks in anticipation of rough work in the Granite Gorge below.

RUNNING THE DANGEROUS HANCE RAPID

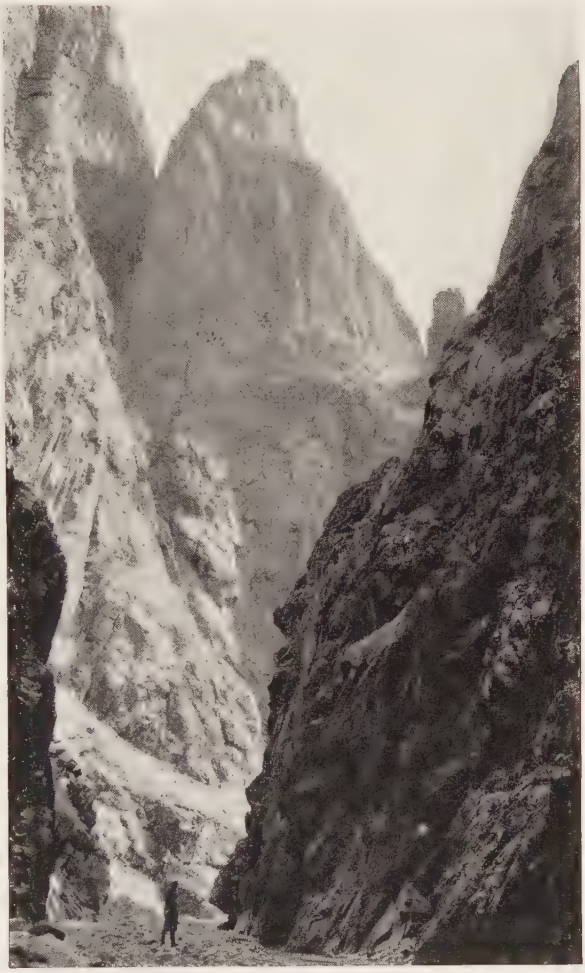
As far as our records showed, no previous party had run all of its boats through the Hance Rapid with its 28-foot fall in the upper section. The portage being a long one and conditions for lining down the side almost impossible at the present

* The Vishnu, Bright Angel, and Shinumo sheets of the Geological Survey represent many years' work by François Matthes and Richard T. Evans, topographic engineers. They are considered equal, if not superior, to the finest work of Swiss, French, and Italian topographers in mapping the Alps.

stage, running seemed worth trying, especially as the mules of the pack-train were available to carry our loads down.

The decision was justified. The emptying of the holds of the boats made an unbelievable difference, not only in their responsiveness to the oars, but also in their ability to ride over waves which would otherwise have buried them. It was a fine sporting run.

After a day spent in going over our boats, we pushed off again on the morning of August 21. A light drizzle of rain was falling as we entered Granite Gorge, but even with that the walls had a less sinister aspect than one expected after Powell's description.



Photograph by E. C. La Rue

LOOKING UP DIAMOND CREEK GORGE FROM A POINT THREE MILES FROM THE RIVER

OVER THE FAMOUS SOCKDOLOGER

An impression of that kind is largely psychological, no doubt. Powell, with dwindling, half-spoiled supplies and battered boats, was facing both starvation and the Unknown; we, with a fully equipped outfit, were pushing on for the foot of the Bright Angel Trail with the prospect of a three-day rest at the hotel on the rim. No wonder we had eyes for the gleaming brightness of quartz, feldspar and mica where the pioneer explorer saw only the forbidding loom of dark walls of igneous rock.

A mile in heavy swirling water took us to the head of the Sockdologer Rapid. Landing 200 yards above the first drop, we climbed down along the right-hand wall to the nearest point attainable to the brink of the opening drop.

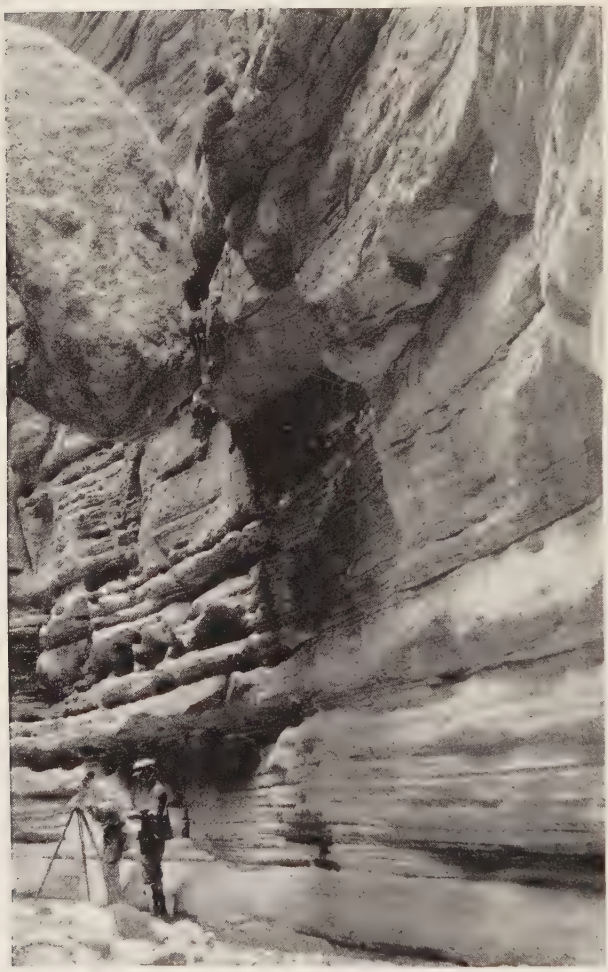
Powell's and Dellenbaugh's estimates of a fall of from 80 to 100 feet in a third of a mile, with waves 30 feet high and spray dashing double that height, prepared us for something on a big scale, though we knew that these figures were rather liberal.

The fact that this was the first major rapid, where the impossibility of climbing round made it necessary to carry the whole party on the boats, lent added interest to the Sockdologer.

The famous rapid was not an entire disappointment, for the initial fall proved extremely abrupt and the waves below were very high; but it was all deep water in mid-channel, with the combers by no means so sharp and broken as when underlaid by boulders. There was plainly no such menace in the rapid as in the Hance and several others already run, where the fall was over rocky obstructions.

As there was no chance to land to set up rods or instruments for nearly a quarter of a mile, some difficulty was experienced in running the survey line, but this was finally accomplished.

Blake and Kolb ran through with one



Photograph by Lewis R. Freeman

MOORE AND BIRDSEYE IN AN UNNAMED SIDE CANYON ABOUT 20 MILES ABOVE DIAMOND CREEK

passenger each; Lint and I with two. The height of the waves was much greater than any we had previously seen, but their evener run gave the boats just enough time to lift over without burying themselves, as in the broken water of boulder rapids. La Rue was not much splashed on the stern of the *Grand;* Moore, on the bow, was bone dry. Not more than the usual amount of water came over the side to drench me and the cockpit. There were only three or four inches covering the bottom boards when I pulled into an eddy under the left-hand wall at the foot of the rapid.

All in all, the run through the Sockdologer was the best sport, from a boatman's standpoint, of any of the voyage, partly because of the great height of the waves and partly because we knew there were no rocks under them to bother about.

Burchard announced the fall of the Sockdologer as 19 feet—less than a quarter of Powell's original estimate and a little more than half of that of the conservative Julius Stone. My own rather vague impression of the height of the waves was from 10 to 12 feet; some of the engineers, with trained eyes for estimating, were inclined to think the largest combers were higher from trough to crest than the length of the boats—perhaps 20 feet.

The Grapevine Rapid, a few miles below the Sockdologer, proved of much the same character as the latter and gave us the same exhilarating runs. The remainder of the run to the mouth of Bright Angel Creek was lively, but not difficult boating.

After three days at El Tovar, the voyage was resumed from the Suspension Bridge (see page 500) on August 27. Herman Stabler (see page 497) joined the party at the foot of Bright Angel Trail the following day. He was a valuable addition to the expedition.

The 70 miles of canyon between Bright Angel Creek and Havasu Creek, the lower boundary of the National Park, were marked by frequent major rapids, many of considerable violence. In spite of the fact that most of the previous navigators had met with serious disasters at various points in this rugged stretch of gorge, our good luck held and our mishaps were largely of a minor character.

Monument Creek Rapid, with seventeen-foot fall, and Hermit Creek, with sixteen, gave us fine slap-banging runs, but nothing worse than good soakings. Hermit Creek, the one major rapid in the Grand Canyon readily accessible by trail

Photograph by Lewis R. Freeman

A GLADE AT THE HEAD OF DIAMOND CREEK

Owing to the flood, the party was four days behind schedule in reaching this point, giving rise to the report that the expedition had met with disaster (see text, page 530).

Photograph by E. C. La Rue

TRAVERTINE FALLS, FIVE MILES BELOW THE MOUTH OF DIAMOND CREEK

from the rim, was run in the presence of a large and distinguished gallery from El Tovar—rather a novel experience for both parties.

KOLB HAS AN UPSET

The distinction of the first upset fell to Kolb while trying to run a rough and hitherto unnamed rapid a few miles above Havasu Creek. It occurred as a consequence of allowing his boat to draw into a deep hole under a large boulder, where it capsized, cupping him under the cockpit. He bobbed up 100 feet farther down and climbed out on the bottom of the overturned boat. With the assistance of Dodge, who jumped in and swam out to the derelict, it was brought to the bank 300 yards below the foot of the portage, and subsequently lined back. Neither boat nor boatman was injured. The event was commemorated in the name of the rapid—"Upset."

At the mouth of Havasu Creek 20 Havasupai Indians, under the direction of Roger Birdseye, brought down 800 pounds of provisions for the long stage to Diamond Creek. Here the cook, who had started with the party from Lees Ferry and who had asked to be relieved some weeks previously, was replaced by a genial Pole, Felix Koms, who completed the voyage with us. The unfailing good nature of the new chef, under conditions which must have been very trying to a roly-poly dumpling of a man weighing 225 pounds, won the affection of every one in the party.

The radio set was sent out from Havasu for repairs, to be brought back to us at Diamond Creek, 70 miles below.

FLOOD SWEEPS DOWN; WARNING NOT RECEIVED

Pushing off from Havasu with deeply loaded boats on the morning of September 15, we came, after three and a half days, to the head of Lava Falls. The skies had been clear most of the way, but violent wind squalls indicated that equinoctial storms were gathering to break upon the plateau region behind us.

If the radio set had been with us we would have received numerous messages broadcast from several stations in response to wires from Washington advising us that one of the heaviest storms of recent years had broken upon the basin of the Little Colorado and warning us to be on the lookout for the waters of a very heavy flood.

If such warnings had been received, we would have selected a broad open section, with ample room to back away from a rise, and waited for the flood to pass. Unwarned, we were surprised at a time

Photograph by Lewis R. Freeman

SHARP PINNACLE NEAR THE MOUTH OF DIAMOND CREEK, FROM FIVE MILES UP RIVER

and place far from favorable—twilight on the brink of Lava Falls.

As the boulder barrier at the head of the rapid offered no runnable channel, the boats were lined down the right side of the most violent section to a narrow crescent of beach below. Beds and cooking outfit were left at the head of the falls, where a few patches of sand among the boulders offered the only feasible camp site. The rest of the outfit was carried down to the boats and restowed in preparation for an early start in the morning. The portage was completed an hour before dark.

Immediately after supper it was noticed that the boats were awash at their moorings, and a few minutes later the beach upon which they had rested was completely submerged by the rising river. As there was no place but the sharply sloping hot-springs formations on which to pull them up, they soon began banging heavily, while the waves from the rapid increased in weight. The *Grand* was in the worst position, being immediately under a ten-foot wall of travertine, with boulders all about. The other boats, for a while, could be drawn up a foot or two at a time as the water rose.

I buffered the *Grand* off the rocks with driftwood until the water was midthigh deep, and then crowded her in to take her chance with the other boats. Meanwhile it had become evident that a better mooring place would have to be found at once, as there was room for only one boat upon the shelf to which the water had now risen, and only an empty one could be handled even there. This would have to be the cook-boat, *Marble*, as the other three were heavily loaded.

FINDING AN ANCHORAGE IN THE DARK

It was now quite dark. All chance of seeking a safer mooring by daylight had been lost. The rest was a night job. Lint and Kolb pushed off in the *Boulder*, the latter carrying an acetylene lantern, and the former pulling cautiously down the eddy beside the lower end of the rapid. The rest of us were kept busy pulling in the three remaining boats and preventing their destruction on the rocks. Lint and Kolb returned in half an hour; they had left the *Boulder* on a sloping beach of

Photograph by E. C. La Rue

SAILING IN THE QUIET WATERS OF BLACK CANYON, BELOW DIAMOND CREEK

limestone a third of a mile below, and recommended that the *Grand* and *Glen* be taken down also.

Kolb rode with me on the bow of the *Grand;* Lint with Blake on the *Glen.* The moon was shining on the opposite wall and a part of the rapid. The latter had lengthened greatly and was booming louder every minute. The illuminated strip of rollers was a ghostly gray and the effect curiously like that of wind-billowed canvas.

We ran as close as we dared to the left bank of travertine, over which streams from the hot springs were falling, gleaming white in the reflected moonlight. There was not much current in the eddy, but a heavy lop from the main chute of the rapid splashed against and occasionally into the boat.

AN EERIE NIGHT RIDE

A distinctly unpleasant odor from the water suggested that the flood was coming from the Little Colorado (see text, page 475). Mingled with this was a humid, almost tropical, smell—rank vegetation and a suggestion of the perfume of flowers.

It was a weird and eerily stirring rather than a wildly exciting ride. Once or twice we were caught by the powerful downrush of the rapid, but a stroke or two brought the boat back to the half-water on the verge of the eddy.

As we doubled cautiously round a jutting point, a new roar from down-river cut into the heavier boom of Lava Falls. Evidently we were nearing a second rapid not far below where the gleam of the tail of the first was quenched in the shadow of a moon-blotting cliff. Then a bay opened up to our left and I pulled into quieter water and beached the *Grand* beside the *Boulder,* on a sloping shelf of travertine.

As there had been no chance to get my bed in the rush of pushing off, I took a lantern and started back to camp as soon as the boats were secured. It was vile work pushing across the slushy, crumbling springs formation, with a tangle of rotting vegetation underfoot and huge thistle and saw-edged grasses growing higher than my head. These pricklers and cutters were particularly unpleasant, since my sole protection against them was half a pair of knickers and one tennis shoe.

THE "TEMPLE," A BUTTE OF CONGLOMERATE ABOVE THE MOUTH OF VIRGIN RIVER

Virgin River enters the Colorado just above the point where the major stream makes its final sharp right-angle turn, flowing due south (see the Map of North America supplement).

Photographs by E. C. La Rue

LOOKING UPSTREAM TOWARD THE WEST PORTAL OF GRAND CANYON

Note the ruins of the old stone house in the foreground. This was once one of the buildings at Pierce Ferry, where a wagon trail from Kingman to Moapa crossed the river.

Photograph by E. C. La Rue

TIME OUT FOR LUNCH

On a narrow ledge 26 miles below the mouth of Diamond Creek.

Photograph by E. C. Kolb

FELIX, THE COOK, AND HIS ASSISTANTS, BLAKE (LEFT) AND LINT (RIGHT), AT DIAMOND CREEK

Photograph by Lewis R. Freeman

THE "MARBLE" IN A RAPID NINE MILES BELOW DIAMOND CREEK

Note the two men clinging to the overdecked bow and stern, while the oarsman in the cockpit pilots the craft.

After fording three or four warm streams, I finally broke through to more open going, but even here there were many cacti. The last 100 yards was along the cliff and over boulders, among which the rising flood was already beginning to swirl.

There were zest and exhilaration in the blind ride in the half moonlight down the edge of the booming rapid, but the tortuous tramp back through the swamp of the hot springs was sodden grief all the way.

In my absence the *Marble* had been dragged several feet above the water, but the spray was already beginning to dash over her again, as the mounting waves banged higher and higher against the wall. I found every one in camp engaged in moving back from the encroaching flood.

RESCUING THE COOK'S BED

We had hardly turned in before it was necessary to scramble back over the boulders and give the *Marble* another hoist. Then we had a rest until an am-

bitious wave came up and surrounded the bed of Felix, the cook. The surprised sleeper awoke in such consternation that he fled, leaving bed and clothing behind in the water. Birdseye and Dodge salvaged the sleeping-bag, and Felix was put to bed again on a higher level.

By morning the water was up to our feet, where we had rolled in after our final move to the last bit of beach under the mesquite. The rapid had unbelievably altered in character overnight. The head of the dam of boulders, where the previous day there had been a series of abrupt falls, was now completely submerged. Over it rushed a broad, solid chute of wildly running water which did not begin to break into waves until halfway down what had formerly been the rapid.

From there on the combers were tremendous—the largest we had seen. They culminated in an enormous uptossed mass of churning, surging water just above where the boats were moored—a point where yesterday there was only a swift but comparatively smooth stretch of current.

This wave was a great boil or fountain, which at times measured all of from 15 to 20 feet from trough to crest. It appeared to be caused by conflicting currents rather than by a rock, and rarely assumed the same form twice in succession.

At times, in breaking back, it cupped down a large quantity of air, which, when compressed, threw out jets of spume like that from a cavernous blowhole on the ocean shore.

A continuous procession of drift logs of great size was moving down the river, some of the largest trees being up-ended and sucked down in whirlpools or, again, almost tossed out of the water. It looked barely possible that a boat might survive a run through the rapid, but only in the event that it could be kept away from several of the largest waves.

A RISE OF 21 FEET IN 24 HOURS

The river had risen 13 feet during the night, to which 8 feet more were added by evening of the second day. The hydraulic engineers of the party estimated the flow at from 75,000 to 100,000 second-feet. We learned subsequently that it had been more than 112,000—slightly greater than that of the last spring rise.

The *Marble* had finally to be hoisted up an almost sheer wall by block and tackle to keep it clear of the climbing waves. The other boats, after unloading, were more easily handled (see page 519).

After a three-days' halt to allow the flood to recede, we pushed off again on the morning of September 22. The increased weight of the water was evident the moment we were well into the current, and when it began to slop aboard in running the riffle under the cliff below it proved to be a veritable liquid mud. A splash of it left a white coating on the skin as it dried, while the effect on the eyes was almost blinding.

Although we had most favorable boating conditions, we were four days behind schedule in arriving at the mouth of Diamond Creek. This fact and the reported sighting of an overturned boat marked U. S. G. S. below the canyon were responsible for the sensational dispatches reporting that the expedition had met with disaster.

SEPARATION RAPID, WHERE POWELL'S PARTY SPLIT

Navigation became more arduous below Diamond Creek. Three days of rough boating in a river with an average fall of more than 15 feet to the mile brought us to the head of historic Separation Rapid, which, with its large canyons coming in opposite each other, was unmistakable from the descriptions of Powell and Stanton.

Here, according to Powell's story, three members of his 1869 party, believing the river expedition was doomed to disaster, deserted and climbed out to the plateau by the canyon from the north. After seeking in vain for a practicable portage along the sheer cliffs, Powell put into the rapid with two of his boats and went through without trouble. The three men who left were killed a few days later by the Indians, though their fate was not learned for many months.

We had no more success than our predecessors in finding a way by which those not needed in the boats could climb round the rapid. Even Dodge, the rodman, who was all but fly-footed when it came to cliff-work, gave up after a persistent attempt to get by. The left wall

Photograph from R. H. Newcomb

DIXVILLE NOTCH, ONE OF THE MOST IMPOSING SCENIC FEATURES EAST OF THE MISSISSIPPI

In the foreground is The Pinnacle, one of the numerous unusual rock formations of this wild ravine, situated near the apex of the State of New Hampshire.

Photograph by Walter Layman

A GLIMPSE OF THE GRACEFUL TOWER OF HARKNESS MEMORIAL QUADRANGLE THROUGH THE ELMS AT YALE UNIVERSITY, NEW HAVEN, CONNECTICUT

In this structure was installed recently one of the finest carillons in the Western World. On a still evening the music of the bells may be heard for miles beyond the confines of the campus.

Photograph by U. S. Army Air Service

NIAGARA FALLS FROM THE AIR

In the foreground are the Canadian, or Horseshoe, Falls; in the middle distance, at the right, is the end of Goat Island; beyond are the American Falls, below which the upper steel-arch bridge spans the gorge and joins the United States with Canada. Father Hennepin, a member of La Salle's party and one of the first white men known to have seen the Falls (1678), described them as "a vast and prodigious Cadence of Water, which falls down after a surprising and astonishing manner, insomuch that the Universe does not afford its Parallel."

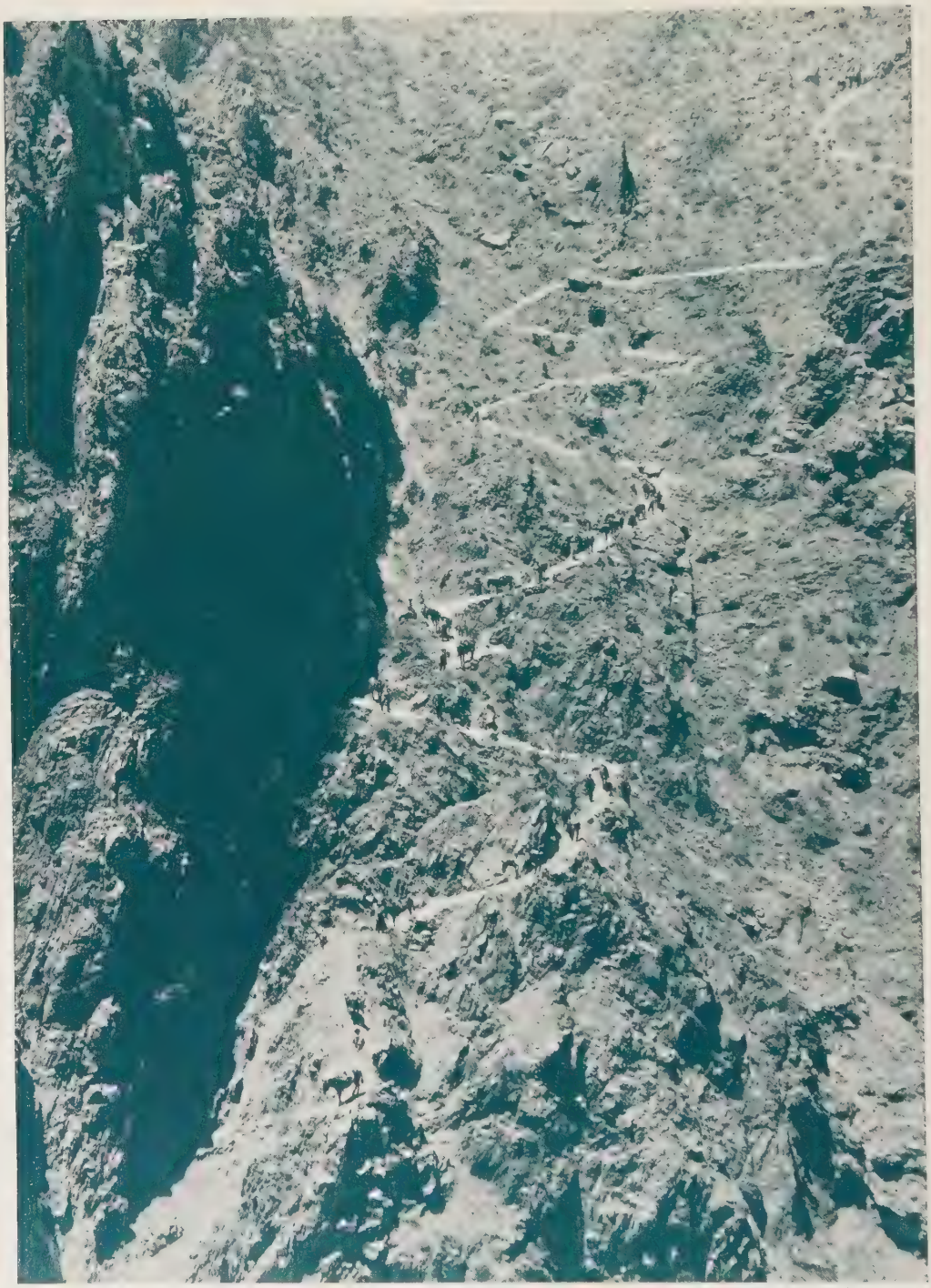
© Aëro Service Corporation

AN AIRPLANE VIEW OF THE LIVING ROCK UPON WHICH IS BEING INSCRIBED, IN GIGANTIC SCULPTURED FIGURES, A PAGE OF AMERICAN HISTORY

Stone Mountain, 18 miles east of Atlanta, Georgia, is a solid mass of granite 700 feet high. Upon its face is being carved a Memorial to the Confederacy (1861-65) at an expenditure of $2,000,000. The distance from the top of the hat of the central figure (General Lee) to the hoof of his

Photograph by H. Armstrong Roberts

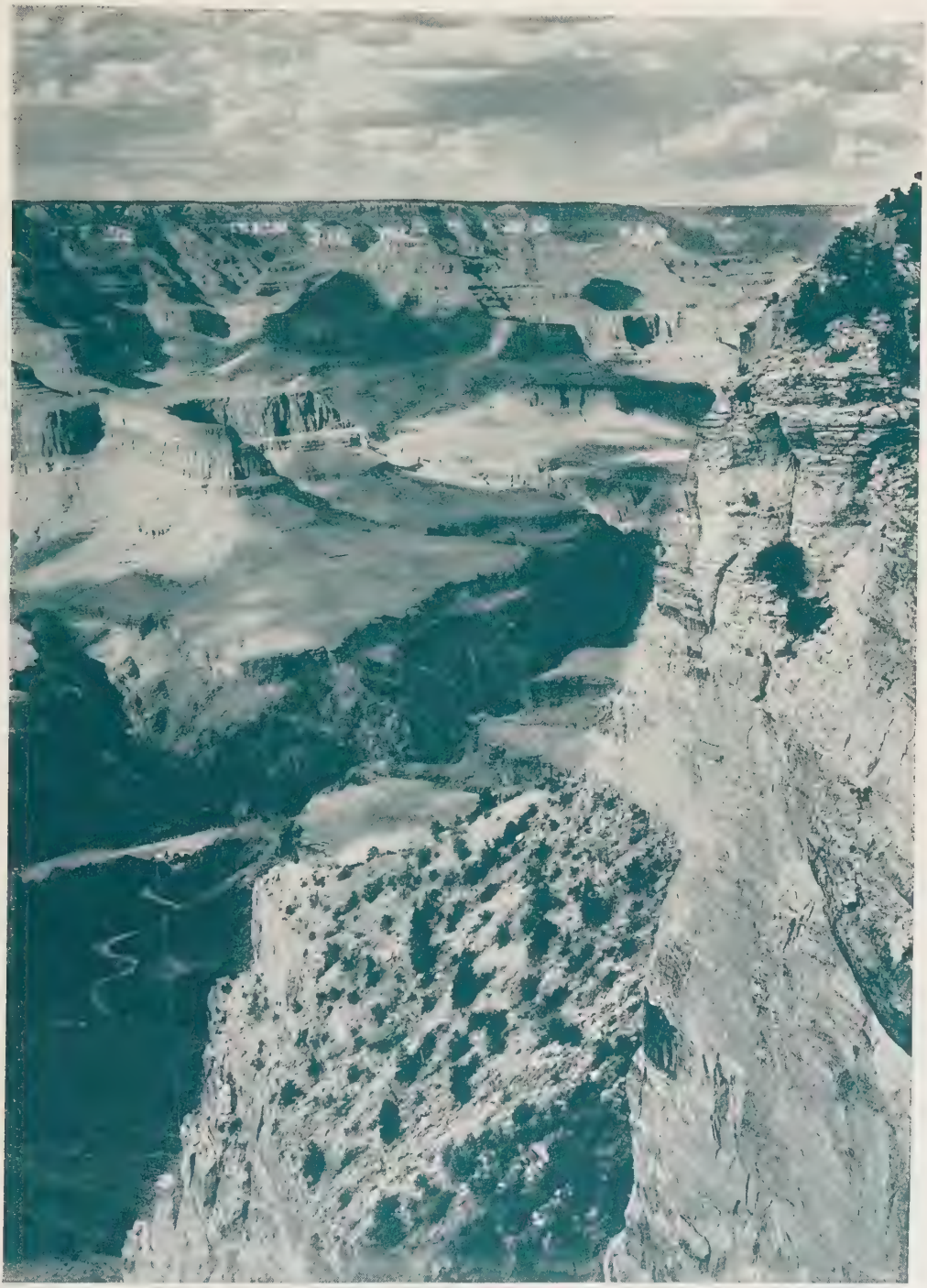
A LESSON IN OCEANOGRAPHY



Photograph by Fred Harvey

DEVIL'S CORKSCREW ON THE BRIGHT ANGEL TRAIL, GRAND CANYON NATIONAL PARK

The majority of visitors to Grand Canyon National Park make the seven-mile serpentine descent from the rim of the canyon to the river by this trail, requiring three hours on horseback and three and a half for the return. The name "Bright Angel" was given by Major Powell (see text, page 471) to the adjacent creek to offset the name of "Dirty Devil," which he applied early in his voyage to what is now known as Frémont River.



Photograph by Fred Harvey

THE GRAND CANYON FROM PIMA POINT, ON HERMIT RIM ROAD

"Clouds and the sunset, moonrise and the storm, transform it into a splendor no mountain range can surpass. Peaks shift and glow, walls darken, crags take fire, and gray-green mesas, dimly seen, take on the gleam of opalescent lakes of mountain water." A spectator standing upon the rim of this "First Wonder of the World" surveys a thousand square miles of varihued pinnacles, towers, bastions, and turrets carved from the rock by the tireless toil of irresistible water.

Photograph by J. K. Hillers

ANGEL'S LANDING AND ITS MIRROR: ZION NATIONAL PARK

The deep reds and browns of this gigantic pyramid are in peculiar contrast to the chalklike El Gobernador, which rises near by to a height of 3,000 feet.

Photograph © Haynes, St. Paul

A CONTENTED NATIVE OF YELLOWSTONE NATIONAL PARK

In the Yellowstone, one of the world's greatest wild-life sanctuaries, bears take care of themselves, but special consideration is given to herds of elk, antelope, and moose.

© K. D. Ganaway

A CHICAGO BEACH, WITH THE FAMOUS LAKE SHORE DRIVE IN THE RIGHT FOREGROUND

The buildings in the background are recently constructed hotels and apartments

© Asahel Curtis

THE HANDIWORK OF NATURE'S MASTER SCULPTOR, THE GLACIER

This scored granite forms the southeast wall of Glacier Creek Canyon, Montana.

© Charles J. Belden

LARIAT PERSUASION

The calf is being induced, none too gently, to submit to the branding iron.

Photograph by Charles J. Belden

ON THE ROLLING SHEEP RANGES OF WYOMING

Two thousand ewes with their lambs can be herded by one man, assisted by a dog or two.

Photograph by H. Armstrong Roberts

BESIDE A WOODLAND STREAM NEAR GLADSTONE, NEW JERSEY

Educational-Bruce Photograph

MORE THAN 3,000 FEET ABOVE THE FLOOR OF YOSEMITE VALLEY

© Asahel Curtis

MOUNT SAINT HELENS, WASHINGTON, ONE OF AMERICA'S MOST MAJESTIC PEAKS

"The head and shoulders of this mountain rise a snowy cone above the purple forest robe and stand as perfectly poised as a Greek statue of marble."

proved to be sheer, though only about five hundred feet in height, rather than the thousand estimated by Stanton. The right wall was more broken and not as high as the other, but still offered no chance to climb.

The *Glen* was the first boat to navigate Separation Rapids and had a heavy tossing in the big waves where the second section beat against the left-hand cliff. Solid water appeared to roll right over the head of Dodge, who was holding on to the stern. The heavy set of current against the jutting right-hand cliff was evidently hard to pull against, but Blake kept clear by a comfortable margin. The third section, with a broad submerged rock in the middle, offered no difficulties.

As I went back to the head of the rapids to take pictures of the two canyons and other features described by Powell, the *Glen* was the only boat I saw run. Kolb went through next, and then Lint. On being told that Kolb had carried dangerously near to the right-hand cliff, I decided to take a chance at putting into the heavy water at the head of the second rapid.

The head of the second or main section of Separation Rapids is the place of which Stanton wrote: "As I looked down into that pit of fury, I wondered if it were possible for our boats to go through it and come out whole, and right side up." A few seconds after that impression was registered, Stanton was in the water and his overturned boat had a hole in it.

THE UNCAPSIZABLE "GRAND" CAPSIZES

Somehow the rapid had not looked as bad as that to me, which was unfortunate. Had I been less confident of the ability of the *Grand* to ride any waves not fanged by rocks, it would have been easy to pull to the right of the heavily running combers and fight it out with the current setting against the right-hand cliff, as the others had done. Instead, I tried only to keep the stern well on to the main line of waves on my left, and so allowed the boat to be caught quartering by a sneaking lump of a comber on the other side. An easy, effortless uplift, the flip of a foam-flecked crest at just the right instant, and the thing was done. The supposedly uncapsizable *Grand* was bottom-up.

My only mental picture of the incident has to do with La Rue's thin legs spidering against the sky as he spilled off the stern hatch, all but falling into the cockpit. Then darkness and much rolling and tumbling of water.

To keep from being cupped under the cockpit, as Kolb had been in his upset above Havasu, I let go my oars and tried to dive. In this I was materially assisted by the swirls. The several succeeding seconds were as active as unpleasant. I pawed water and gulped water, but didn't seem quite able to bring the surface down where I could use it.

Finally a violent swirl carried me to the top, but only to suck back my protesting anatomy so quickly that the breath of air I tried to get ended in a bite of water. This time the submergence was brief, and as my head came up again I managed to gulp a lungful of mixed air and spray.

The downward pull was still strong, though intermittent, and my head continued to duck under now and then, as I lunged off after the boat, drifting 10 or 15 feet below me. I had the feeling that my saturated life-preserver jacket was giving very little support, but this may have been due to the drag of the current on my very heavy hobnailed shoes.

Moore, minus cap and glasses, was riding contentedly by one of the side ropes. La Rue was not in sight. The spectacle of the right-hand cliff seemingly about to topple over on us, as the boat was carried under it, was a bit disturbing, as one could have no illusions as to which would get the worst of it in case of a collision. The disappearance of the ominously looming wall and a throaty croak from the other side of the boat announcing that La Rue was still a passenger disposed of the chief worries of the moment.

A splash and a quickening of motion signaled the entrance to the third riffle. From above, squarely in the middle of this, the current had appeared to break in a broad, low wave over what must have been a large flat rock, fairly well submerged at the present stage. It hardly looked capable of precipitating a violent smash at the worst, yet I was glad to see our derelict giving it a wide berth to the left.

The boat danced at a merry pace on

Photograph by Lewis R. Freeman

RIGGING SAIL ON THE "GRAND" 50 MILES ABOVE NEEDLES, THE END OF THE VOYAGE

through the rest of the riffle, but not in a way to make it hard to hold on.

THE "GLEN" IS UNDAMAGED

Moore and I climbed up on the bottom of the boat as soon as it floated into quieter water, but as La Rue appeared somewhat dazed it was not practicable to attempt to right her in midstream. This was accomplished as soon as Blake and Dodge, on the *Glen,* had worked her in to an eddy against the left wall.

Baling hastily, I replaced a lost oar and pulled across to a beach on the opposite side to dry out. The little water that had entered the holds had done no harm, even to an unprotected sack of sugar. The only losses of moment were Moore's colored glasses and several irreplaceable geological specimens, loose in the cockpit at the moment of upset. My missing oar was picked up a few miles below and restored to the mate with which it had worked all the way from Lees Ferry.

Lava Cliff, the rapid considered by Stone as the worst in the whole Colorado Canyon series, was passed by intricate and laborious lining on October 11 and 12.

Burchard, the topographic engineer, who was handling the instrument in running the river line, was the victim of two bad falls the day we left Diamond Creek. In the first, when he was precipitated upon a barrel cactus with fishhook spines, he was saved from injury through the fortunate circumstance of having used the leg of a discarded boot to patch the seat of his trousers.

In the second fall he landed upon the corner of his instrument box and fractured a rib. Although in much pain at times, he stuck gamely to his work, and on October 13 was rewarded by picking up with his instrument a little pyramid of white stones on a jutting point ahead. It was the monument marking the highest point reached by his up-river survey of 1920. When the two surveys were tied in, their elevations were found to check within four feet.

There were many splashy rapids remaining below us, but none which required a preliminary reconnaissance. With the survey completed, progress was speedy. We ran out of the canyon on the first day, and on the fourth day from the Grand Wash our boats were tied up at Needles. More than 50 miles a day had been averaged where the broad, shallow river wound down through open valleys.

The party disbanded at Needles on October 20, just over three months from the date of departure from Flagstaff. The *Glen, Boulder,* and *Marble* were returned to the Southern California Edison Company; the *Grand* was shipped to Washington to be put on permanent exhibition at the Smithsonian Institution.

THE ISTHMUS OF TEHUANTEPEC

By Herbert Corey

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ONCE upon a time the Isthmus of Tehuantepec was—potentially, at least—a most important neck of land. A king of Spain considered joining the Atlantic and Pacific oceans by cutting a canal through it. It was a pathway for the Argonauts who rushed to California in the golden days of '49.

Captain Eads, who built the steel arch bridge at St. Louis, won attention by his scheme to construct a ship railway over it. One can laugh at it now, for his plan was to build a multiple-tracked railroad up hills, through bogs, rounding sharp curves, on which to creak laden cargo boats on huge wheeled cradles. The largest vessels he hoped to carry would hardly class as tenders alongside the monster tramps of to-day. But at the time the world talked about it.

A treaty was negotiated between the United States and Mexico for the construction of a half railway, half canal, for the shortening of the goods route around Cape Horn, in 1850, and a commissioner was empowered to promise $30,000,000 for the right of way. This came to nothing, and after fifty years of futile effort a government-financed road was finally built, which was opened to traffic by President Porfirio Diaz in 1907.

Sir Weetman Pearson, one of the greatest of modern engineering geniuses, installed huge docks at Salina Cruz, on the Pacific coast, and Puerto Mexico, the Atlantic terminal, which are even to-day among the finest in the world.

Perhaps no railroad enterprise ever attracted wider attention. The conception was romantic and daring, for while there were no great heights to climb—on the Isthmus the cordilleras which form the backbone of the continent flatten out, so that the extreme elevation at Chivela Pass is but 730 feet—a great part of the 189 miles of road was built through a jungle which in the rainy season becomes a dangerous quagmire, where the vegetation grows so furiously that the physical existence of the road is almost imperiled.

Yankee capital by the million was poured into the various Isthmian enterprises. Bananas, pineapples, sugar cane, cotton, coconuts, almost any tropic fruit you can think of, grows while you wait. The grower's effort is not to make a crop, but to defend it against the suffocating inroads of the jungle.

Success seemed certain, for the ranches were assured of river transportation to the sea. There were rolling prairies on which cattle could be fattened and a score of valuable woods could be had for the taking. Those were days of order and prosperity.

Then came the ruinous competition of the Panama Canal, followed by the Mexican revolution and the revolt of Mexican labor, and finally the World War.

RANCHES ABANDONED, DOCKS EMPTY

To-day most of the great ranches are practically abandoned. The great docks are almost empty of ships. At one time twenty freight trains ran each way each day on the trans-Isthmian railroad. To-day one mixed train, with two filthy, rackety passenger cars tacked to half a dozen half-empty freight wagons, serves what inland business there is. Sometimes the bandits interfere, and then the trains are marooned in whatever jungle island they may be.

Yet it is difficult to avoid the conviction that one of these days the Isthmus will again bustle with business. After all, the Tropics have been conquered. The English have made jungles pay in a score of places; our own experiments in the Philippines and the Panama Canal Zone have been eminently successful; France and the Netherlands have succeeded. When the world needs the Isthmus the jungle will obey orders.

One approaches the Isthmus through the city of Córdova (Cordoba) (see Map of North America, published as a supplement with this number of The Geographic). There are other ways, of course. One may start from the white-

Photograph by Clifton Adams

A CORNER OF THE TEHUANTEPEC MARKET EARLY IN THE MORNING

The white building with numerous columns is the Palacio Municipal. In the foreground is one of Tehuantepec's dependable four-legged street cleaners (see text, page 555).

hot platter of Vera Cruz, sizzling on its flat shore on the Bay of Campeche, or ride six days through the mule-wide paths from the city of Oaxaca, or take steamer to either of the terminal ports of the Isthmian railway; or, having reached Guatemala, one may take the International Railway north; but the most desirable gate is that of Córdova. One is thereby assured of a pleasant memory.

We had been struggling on a narrow-gauge railway from the city of Oaxaca, going around Robin Hood's barn, stopping for repairs, listening to stories of brigands, spending nights here and there, seeing interminably an iron country of gray rock and brown sand and greenish sage.

At each little station a squad of undersized Indian soldiers crawled reluctantly from the shade and perfunctorily went through various ritual motions. Dust swept through the open windows in clouds.

Almost without warning, we came into the Tropics—warm, lush, overmastering. The air was soft and heavy; it seemed the texture of warm cream. The hills were covered by masses of verdure, laid on in thick clots, as by the sweep of an overladen brush.

LIFE IN THE PLAZA OF CÓRDOVA

"This is Córdova," said the very superior hotel runner who had captured us. He dusted his elegant boots languidly with a somewhat soiled handkerchief, summoned *cargadores* with imperious wiggles of the finger, and bowed us out of the car with elaborate courtesy.

I felt the dramatic unities could only be preserved if the orchestra crashed as we were welcomed by a group of merry villagers. The city was theatrical. One walked against a backdrop of Moorish houses whose reds and blues had been softened by the years.

That night I sat at a glistening table and looked out at the dim plaza through wide arches and drank red wine from Spain. Parrots squawked and chattered. Officers of the army entered at intervals to greet with loud cries the fortunate comrades who were already seated. They dropped their equipment with crashes by their chairs and shouted for the waiter. Pretty ladies came in and sat alone.

One does not get the full savor of Mexico until he has acquired the plaza habit. The two beggars with the guitar and mandolin began to work their way around the square, tinkling the soft, mournful airs descended to them through a complicated ancestry of Moor and Spaniard and injured Indian. A weak and homesick sentiment was induced by an environment that was rich in beauty. At each of the four corners of the little plaza rose a single royal palm, its tufted head feathering high. The air was heavy with the perfume of flowers.

Tiny electric lights sparkled starlike against the velvety blue of the heavens—a blue that was at once deep as infinity and yet so tangible that it seemed as if one might plunge one's arms in it, as in a pile of tumbled silken floss. The torch fires of Orizaba were slowly burning out overhead, as the last rays from a long-hidden sun were reflected from his snowy summit and shot through the blue pale flashes of gold and pink and a storm-cloud gray.

From somewhere near by came the sound of childish voices in song. The tune was at last identified as "London Bridge Is Falling Down," and the words were Spanish.

A bull fighter's costume, stiff with gold, gleamed in a shop window under the graceful portals.

The butchers' tramcar rattled by, with racks filled with the afternoon kill of country beef, protected by mosquito nettings. It was drawn by four mules, although Ford engines, set in pairs, furnished motive power to others of Córdova's trams.

The band began to play.

There are innumerable bands in Mexico. Each town large enough to have a plaza has some sort of a band, unless the bandsmen have been killed or driven away in the war.

The Mexican band is, almost without exception, worth listening to. One wonders where it conceals itself during the days of early travail. An immature Mexican band is never heard.

COFFEE IS SERVED IN EXTRACT FORM

It was at Córdova that I abandoned the effort to have my morning eggs boiled four minutes. A Mexican egg, one eventually learns, can be and usually is fried

Photograph by Clifton Adams

A LADY OF JALAPA WITH HIGH COMB, MANTILLA, AND ABANICO (FAN)

The population of the Isthmus of Tehuantepec remains predominantly Indian, but on the central plateau, where climatic conditions have been favorable, there are many inhabitants of pure Spanish stock who possess the grace and charm of old Castile.

Photograph by Clifton Adams

IN THE PATIO OF A JALAPA HOME

Jalapa, connected by rail with Vera Cruz, lies to the north of the Isthmus of Tehuantepec. Beautifully situated 4,400 feet above the sea, it is one of the most favored of the summer resorts of Mexico.

Photograph by Clifton Adams

EARLY MORNING ON A TRAIL IN THE MOUNTAINS ABOVE JALAPA

When Cortez, with his little band of Spaniards, climbed to the thriving Indian village of Jalapa, which has now grown into the busy capital of the State of Vera Cruz, with 20,000 inhabitants, he enjoyed one of the most beautiful views the country affords. Mount Orizaba, in its white robes, looms up to the south; the Sierra Madre, with its dark groves of pines, to the west, and below are the meadows of the lowlands.

very hard, so that as an item of the meal its durability compels respect. Hard-boiled eggs can be had of the street venders at every curb. There are various phrases for use by the person who wishes his eggs boiled to a bland medium, but no matter how one may vary the form of the order, one's eggs are always *tibio,* which means lukewarm, and the twin elements can readily be imbibed through a straw.

I had descended to the hotel office in search of coffee with which to gild the dawn. A peon or two slept on the wide, dusty floor, in front of the great doors, open to the fresh morning air. The miracle of Orizaba could be seen hovering in the heavens, a shimmering filament of pearl. One began to understand how those who live in the shadow of such beauty have it unconsciously in mind at all times. The vacant-minded peons sit by the hour in the street of Córdova and watch that glittering peak (see page 558).

"Hay coffee?" I asked the hotel clerk.

The inquiry was tactless, but at such an hour one can not be a Raleigh to order. He was leaning across the counter, listening to a radiant little creature in a short green dress. I made careful notes of her costume, as I sat grumpily at a table. Her stockings were silk and white, her shoe heels very slender and very high, and a *rebosa* of figured red silk was looped about her graceful head. A tortoise-shell comb, big as a dinner plate, was thrust in her purplish-black hair. She went through the motion of whipping out a knife and thrusting it at the midriff of the fascinated clerk and shouted "Hah!"

"Si," said the clerk, "the coffee." He exchanged patient smiles with the flashing señorita at the desk.

In the midst of the raffle of catsup bottles and sugar bowls and salt shakers was a great bottle, filled with the blackest extract of coffee. In the hotter parts of Mexico coffee is boiled down to a midnight essence and bottled. One then mixes it with warm milk to please one's own palate, and is thereby faintly assured that one detachment of the army of germs one suspects lurks around every gastronomic corner has been circumvented.

The number of dietary taboos one discovers in tropical Mexico is alarming. Pork, no matter how well cooked, may be a poison to the Gringo, for the food of the ravening pigs consists in great part of the filth made available by Indians, who have not the faintest ideas of sanitation. Beef must be cooked to an oaken dryness before it is safe.

In front of the hotel at this hour passed a procession of laden burros. Men rode to the day's work on snappy little horses, and pack animals ambled in half buried under mountainous loads of green and rustling cane. The cargadores yawned, as they squatted along the wall under the first warm rays of the sun.

The women here seemed clean and well dressed and modestly self-possessed. One suspects more than a dash of African blood in Córdova, and the vigor and independence of these women are probably due to the comparative prosperity of the town. Córdova is in the heart of the coffee district of Mexico, and while farming has been interfered with, as has everything everywhere by the revolutionary excesses of the last decade, the coffee farmers seem to have suffered least.

RAILROAD TRAVEL ON THE ISTHMUS IS AN ORDEAL

The Isthmus of Tehuantepec is shared in about equal parts by the States of Vera Cruz and Oaxaca. It runs east and west, which does not agree with one's half-forgotten memories of the map, and the trans-Isthmian railroad crosses it from north to south.

That part of the Mexican territory included in the Isthmus proper is, perhaps, 200 miles east and west by 150 miles transversely. The greater part of it is wet, heavy, almost impenetrable jungle, although on the Pacific coast there are lands on which rain hardly falls at all.

One of the National railways forms a Y, with the points at Vera Cruz and Córdova and the intersection at Tierra Blanca, to connect with the trans-Isthmian road at Santa Lucrecia.

The ruin of the Isthmus began to be apparent even before we had taken our seats in the ramshackle little car for Tierra Blanca. The architects of the station at Córdova had had progressive ideas,

Photograph by Hugo Brehme

A CREVASSE IN THE SNOW FIELDS ON IZTACCIHUATL

The summit of the mountain, which is known geologically as the ruins of a volcano, consists of three elevations covered in pure white snow perhaps three acres in extent. It is not difficult of ascent and is usually scaled along the south arête from the pass facing Popocatepetl.

Photograph by Hugo Brehme

VEGETATION ON THE SLOPES OF IZTACCIHUATL (SLEEPING WOMAN)

The mountain derives its name from a fancied resemblance to a recumbent female figure. It is linked to Popocatepetl by a deeply curved saddle, over which Cortez built a military road in order that he might advance in 1519 to the conquest of the Valley of Mexico. It wears a cap of eternal snow extending 2,000 feet below its crest, which is 17,323 feet above sea level.

Photograph by Hugo Brehme

ON THE ROAD TO THE PEAK OF ORIZABA, KNOWN TO THE INDIANS AS CITLALTÉPETL (MOUNTAIN OF THE STAR)

This volcano, the second highest peak in North America, lifts its crest more than 18,000 feet above sea level. One writer has said, "Orizaba has what mortals rarely possess united—a warm heart, with a clear, cold head!" Though the mountain is not very accessible, American officers of General Winfield Scott's army scaled it and planted a flag on its summit in 1848. Long quiescent, Orizaba was reported in eruption two months ago.

but nowadays one approaches it by pig-encumbered paths through the mud. The status of the pair of daily trains, one of which arrives at night and the other departs in the morning, was set forth on a blackboard. Their lateness varied by hours.

The first-class coach had been a box car in happier days. It had been converted to the uses of the passenger traffic department by cutting square holes to serve as windows, and carpentering-in small, perpendicular slat seats, which were disappointingly cushioned in black oilcloth.

Some of the train guard rode on the roof and some on the rear platform, armed with rusty rifles of various makes.

THE JUNGLE A TANGLE WHERE REPTILES LIVE HAPPY LIVES

When we came to the jungle I was not tempted to enter it. It was thick, tangled, two-storied, where the comparatively delicate plants, unable to live in the sunless cavern at the earth's surface, had mounted to the upper branches of the rioting trees.

Under foot was a swamp, penetrated with streams of muddy, stagnant water in which various reptiles lived happy lives. Palms, wild bananas, bamboos, knotty, twisted trees of a dozen sorts, were underlaid with matted growth.

The natives carried their machetes swung to the shoulder, and one saw them chopping their way along the narrow paths, worn smooth by slapping native bare feet, into the profundities of the jungle.

But for the first half day's ride we passed through a country of unbelievable fertility. The cultivated lands were of a uniformly red tint, which glowed against the heavy green of the vegetation.

We rode for miles through plantations of pineapples and plantains and sugar cane. The broad, glossy green leaves of the coffee bushes shone between the rows of huge banana plants, where they had been set for protection from the sun.

In front of the roadside haciendas were wide cement floors, on which at harvest time the coffee berries were spread to dry. Between times they offered convenient playgrounds for the wandering pigs. Tinkling streams dashed down the mountains and under arched bridges.

The newcomer first sees in this land the wasted opportunities. Enough foodstuffs might be produced on the Isthmus to feed the entire Republic, which now imports a large part of its food. The land is as fat as an Illinois river bottom, and the procession of rain and sun forces vegetation hothouse fashion.

The primal curse has been almost lifted here. A native who wishes to raise a crop of corn needs only burn off a patch of grass and drop the seed in holes made by a pointed stick. He never dreams of cultivating or weeding it. Next year he burns off another patch. His hens rustle for themselves and his pigs live a discontented but earnest existence, at their own cost. His greatest activity is to move from a patch of sunlight into a cooling area of shade.

We discovered that life in a tropical jungle is a constant battle against foes that we fortunates of the north have never heard of. The right of way of the railroad is only kept clear of encroaching vines by an alternate process of burning and mowing and soaking with boiling chemical solutions. Seeds blown by the winds find lodgment in the crevices of stone walls, and in a few years a well-built house looks like a relic of the Spanish invasion, so thoroughly has it been torn apart.

Fevers and agues and insect foes are everywhere.

There is the hookworm, of course, which accounts for some of the lassitude of the people, and the screw worm, which bores into one's flesh, and keeps on boring after it reaches the bone. This is the home of the "chigger," which makes a hive of its host and produces ulcers.

There are flying pests which poison the flesh if they but light on one, and enormous ants and little red bugs which come up from below and produce a fiery irritation. Flies settle in masses, and at night mosquitoes plague, and a devilish little flea abounds, and gnats swarm in one's eyes.

MOUNDS MARK SITES OF BURIED CITIES

We rode through wide pampas on which a few cattle stood horn-deep in

Photograph by Clifton Adams

THE "CÁRCEL," OR JAIL, IN A VILLAGE OF OAXACA

The men on the outside of the door, constructed of heavy beams, are visiting the offenders, who have been guilty of drinking too much pulque, a fermented beverage made from the juice of the agave. The Isthmus of Tehûantepec lies partly in the State of Oaxaca and partly in that of Vera Cruz.

Photograph by Clifton Adams

AN INDIAN FAMILY IN AN OAXACA VILLAGE SHOWING THE FAVORITE FAMILY SERAPE DESIGN

These designs often represent some of the better known of the ancient Aztec gods and are incorporated in the weave of the serape in all colors of the rainbow.

grass, as fat as butter. Not far away is the National Valley, in which the best tobacco in Mexico is produced.

In the distance were shapeless mounds which are the remains of buried cities. Beyond doubt this fecund land once maintained an immense population. Even at the time the Spaniards came, it was prosperous and populous, although it seems to have been decaying slowly ever since. Seventy-five years ago there were towns where there are now only memories.

In the reports of the engineers who laid out the schemes for the interocean transportation ways, one reads of great herds of cattle and of large estates. They have been almost swallowed up by the jungle.

As the train rattled south toward the Isthmus proper, clacking at every loose joint in the rails that bent under it on rotting sleepers, a likeness to an African landscape appeared. The houses became conical huts with roofs thatched with palm leaves, Congo fashion.

Palms rose among the reeds on the banks of the River Papaloápam (Sto. Domingo), one hundred yards wide, on whose swift current little whirlpools swirled and disappeared. High-prowed dugouts were paddled by half-naked men. This river is navigable for light-draft steamboats, but there was no business for them at the time of our visit.

Fruits of every tropical sort were offered at the wayside stops. The routine of papayas, mangoes, chirimoyas, was varied by slices of small greenish-white and almost tasteless watermelon.

One wondered why the train stopped at the stations, for nothing was taken on or put off.

SANTA LUCRECIA IS BUSTLING ONLY BY CONTRAST

The ride was almost monotonous until we reached the station of Santa Lucrecia. One can not keep one's interest alive in a solid wall of green, varied only by pools of stagnant and miasmatic water. It is true there were a few sugar mills, idle for the most part, and at El Burro a

Photograph by Clifton Adams

THE CHURCHYARD OF SANTA MARÍA DEL TULE AND ITS FAMOUS CYPRESS

Not far from the city of Oaxaca stands a tree of the cypress family 160 feet high and measuring 160 feet in circumference four feet from the ground. Legend says it sheltered Hernando Cortez and his troops en route to the conquest of Honduras four centuries ago. Baron von Humboldt, the naturalist, was so impressed by this giant tree that he inscribed his name on the trunk, part of the inscription being visible to-day.

Photograph from Harriet Chalmers Adams

A PACK TRAIN ON THE ISTHMUS OF TEHUANTEPEC

Most of the hauling in this part of Mexico is done on primitive carts drawn by oxen while trains of heavily-laden burros provide the chief means of freight transport where trails take the place of roads.

Photograph by Clifton Adams

THE FLOWER STALL IN THE MARKET OF TEHUANTEPEC

Many of the Tehuana women are adept at weaving chains and wreaths of jasmine blossoms. Small holdings on the outskirts of Tehuantepec are devoted exclusively to the growing of flowers and on Sundays and Thursdays the fragrant market is riotous with color.

peon slept with the dogs under the stand on which the local butcher displayed some strings of thin, yellowish meat, his head pillowed on the raw skull of an ox.

Unclean soldiers squatted with the pigs under the houses, raised Malay-fashion on piles against the annual inundation.

At some of the banana plantations were octagonal watchtowers, solidly built of stone, which served as shelters against the bandits or patriotas or whatever other human plague might be current.

Placards on the stations warned against carrying arms. There had been too much shooting and cow-killing.

By contrast, the little station of Santa Lucrecia fairly bustled. Here was a hotel in which one might sleep in a room that had been swept out at intervals. The sheets were almost clean, although there were ominous brown spots on the dirty walls. The wallow in which the hotel refuse was thrown and which was frequented in dispassionate comradeship by the pigs and buzzards was fully forty feet away. A peripatetic barber labored in his vocation under the roof of the waiting shed, where Indians slept in the dust.

KINDLY MEXICAN INDIANS BEFRIEND AMERICAN TRAMPS

There were other houses—a dozen, perhaps—and other hotels set on piles over a solid carpet of snoring pigs. There were American railroad "stiffs," as there were at every other junction point in Mexico.

"We are on our way from Guatemala," they said, "and we are hungry for ham and eggs."

Surely no poverty-stricken people in the world are more kindly than the Mexican Indians. With no reason whatever to be kind to white folks, the destitute wanderer never appeals to them in vain. The railroad "stiffs" had been making their way a station at a time. At each stop they would be thrown off the train, and when the next day's train came along they got back on again. Between times they lived on the Indians.

Here the Coatzacoalcos River (River of the Winding Snake), the largest on the Isthmus, offers water transport to the Atlantic coast. In the shallow water near shore sat naked women, scrubbing their brown bodies with sand. Two pretty washerwomen had erected a brush-roofed stand near the water, under which they had propped, waist high, great tubs hewn from logs.

A handsome, slender woman in black asked for gold pieces.

"I will buy them," she said. "I want them for my necklace."

The Isthmian native does not regard work as the chief end of man. When a livelihood can be picked up so easily, he feels no call to toil. Now and then he is stirred by ambition and works until he gets a new knife or a new sombrero, but a steady job has no attraction for him. High wages mean nothing to him, and the Americans who thought to make him joyless and self-respecting by thirty days' work a month have changed their plans.

Because piecework is the only way in which Indian labor can be handled, the Americans were forced to keep several times as many laborers as they needed.

Sometimes there is a brief flash of hope. A lover goes to work to buy his best girl a silk handkerchief or a ring. The girl becomes the object of neighborly envy, and the other girls work in order to get money to buy gauds that will cast a dense shadow over the first girl. She works for a time to maintain her supremacy.

"But by and by," say the employers, "they all get shoes or brass rings or handkerchiefs; or else they get married or get tired."

WHERE THE FORTY-NINERS CROSSED

Suddenly we left the jungle. On one side of a rocky ravine it dripped and breathed and rotted. On the other we were already on the dry hills.

The road ran through a rolling country, dotted with clumps of tangled brush and clothed with gama grass, on which a few cattle grazed. In the distance the blue hills were covered with marketable timber. There were tunnels and cuts in the cliffs, and salt-water breezes put life in the air.

On the front of a well-built station, lonely in the hills, where half a dozen bare-belted Indian women offered cold boiled ears of corn to the hungry, was the name Sarabia. Here the Forty-niners left their canoes to tramp overland for the Pacific coast. The river itself was a little

Photograph by Clifton Adams

THE TOWN OF TEHUANTEPEC AND THE VALLEY OF THE TEHUANTEPEC RIVER, 21 MILES NORTHWEST OF SALINA CRUZ, ON THE PACIFIC

The statement that the highest point on the Tehuantepec route is nearly 730 feet gives little idea of the engineering difficulties. The Pacific slope of the continental divide is so sharp that a series of reverse curves and toboggan-like inclines makes the road so crooked that it has been said "the brakeman on the caboose could light his cigar from the headlight of the locomotive."

one, hardly fifty feet wide and perhaps knee-deep. One could see the rocks of the bottom through the clear water. For miles the Forty-niners walked in it and pushed their canoes.

Our spirits dropped at Rincón Antonio. This had once been a well-built village of burned brick, where were the headquarters of the railroad officials, away from the steamy heats of the two oceans. Once there had been railroad shops and commodious yards.

The long row of brick houses in which the officials of the road had once lived, with their families, now sheltered Indian workmen, Indian fashion. Decrepit, rusty, unkempt cars and engines were scattered through the almost empty yards. The man who shared my seat had lived in that very row during the good times.

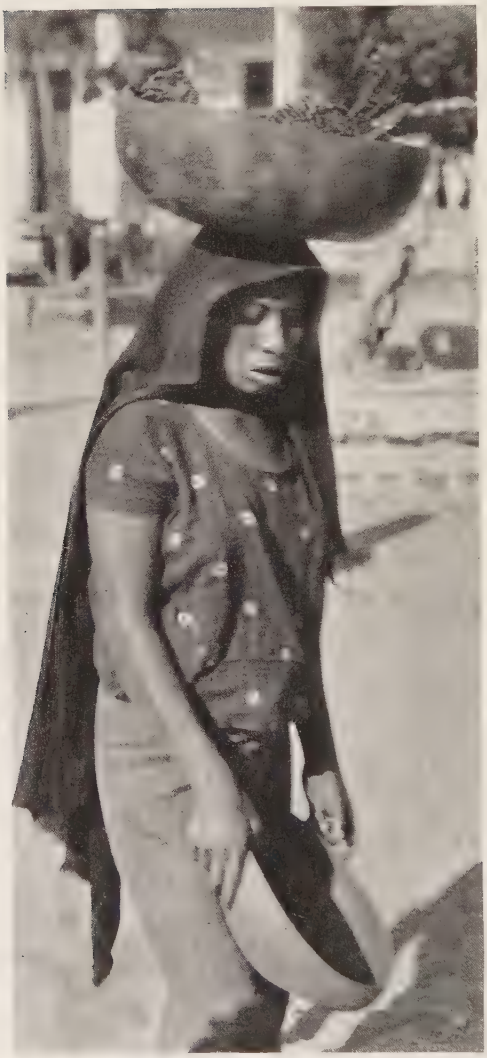
"It seems impossible," he said. "Then it was such a lively, clean, snappy town. There were American women and children and a bright, attractive club, and music and sports. Now it is slipping back toward the status of an Indian pueblo."

An American stood on the platform of the little station of the City of the Beautiful Women. There was nothing particularly

Photograph by Clifton Adams

THE FRUIT MARKET OF TEHUANTEPEC

Almost every sort of tropical fruit is to be had here. Beneath a great tiled roof, supported by immense pillars of masonry, pineapples, chicos, coconuts, oranges, lemons, and mangoes are piled high in hampers.



Photograph by Clifton Adams

CARRYING A CHICKEN HOME FROM MARKET

significant or even interesting in that. One sees them wherever one goes through this country—khaki breeches, O D shirt, Stetson hat, hands in pockets. If the American wears a coat, he may have a gun tucked away under the left arm. As a rule, they go unarmed; for, as one explained:

"If you have a gun, the chances are you can't get at it in time. The other fellow will shoot you from behind; also, if you have a gun, some local capitano will take it away for his own use and fine you into the bargain."

They scout through the country on all sorts of errands. Sometimes they have salaries and expense accounts and sometimes just curiosity and appetite. Sometimes they are hunting jobs and sometimes they are brisk young rovers who are taking a look at Mexico, just as later on they may drift into Turkey or London or Shanghai. They will turn their hands to anything that is not too permanent, from section hand to storekeeper. A banker I know came out as a "lunger" and got his first job keeping claim-jumpers off a mine. He sat in the sun all day with his rifle in his hands.

"I would not have shot if they had jumped the claim," he says now. "I was too sick. But they didn't know."

One of the greatest of the Mexican oil millionaires began his explorations as a camp cook.

THE FAMOUS BELLES OF TEHUANTEPEC

The city of Tehuantepec is very much like any one of the cleaner towns of the central plateau. It has a plaza, on one side of which is a substantial market house. During the day the beautiful women meet there to buy and sell and talk, while the men hang sullenly around the dusty streets or sit in doorways and look on (see pages 550 and 567).

As night comes on, candles begin to twinkle in the market house over white-clothed tables. It is the city club, the chamber of commerce, the sewing circle, the principal restaurant, and the Ladies' Aid Society of Tehuantepec.

The men and women wander from one table to another, buying food and drink by the centavo's worth, talking, smiling, clattering. To the eye of the stranger they seem very happy.

In an hour or so the candles burn out, the tables are cleared away, the women stalk off to their homes through the dark, quiet streets, their burdens on their heads. Sometimes a faint strain of music is heard through an opened door. The stars shine very brilliantly and very near. The story might be written of hundreds of little, unimportant, unknown towns throughout Mexico.

Tehuantepec's sole claim to fame rests on the good looks of its womankind. They march through the streets, erect,

Photograph by Clifton Adams

INDIAN WOMEN COMING FROM THE MARKET AT TEHUANTEPEC

The *jecapeztes* (decorated gourds) sometimes exceed two feet in diameter. The center of their manufacture is Santa Maria de Guiniagate, a town lying among the hills about 25 miles west of San Gerónimo.

bare-footed, their ankles hidden by a froth of white drapery that escapes from beneath a skirt that may boast a score of hues, wrapped about the hips tight as a Burmese sarong and tucked neatly in at the bare waist. The short chemisette, armless and low-necked, offers a kaleidoscopic variety of color built on a foundation of Turkey red.

Sometimes one sees the royal purple of old Tyre—the Tyrian purple with which argosies were once freighted to the barbarians—for the same shellfish the Tyrians robbed lives on the sand banks of the Pacific coast.

That is the every-day dress—a floating chemisette of many colors, a belt of bare, silky brown skin—the sarong twisted tight about the hips to end in a frivolous ruffle of white plaits that swirls and

Photograph by Clifton Adams

BIDDING THE VISITOR GOOD-BY

The girl on the left is wearing the *huipil grande* in the proper position on her head for a walk in the street. It is also permissible to carry the headdress folded over the arm, as shown at the right.

Photograph by Clifton Adams

READY FOR CHURCH

The white *huipil grande* is worn in a number of ways by the higher class of Tehuana women and makes known the owner's social status. This costume is suitable when the wearer is on her way to mass.

Photograph by Clifton Adams

RESPONSIBLE FOR THE FAME OF TEHUANTEPEC

The Tehuana Indians belong to the Zapotec tribe, which, according to tradition, built the great fortress of Mitla. The women have been noted for their beauty for many generations.

Photograph by Clifton Adams

THE JOLLY SEÑORA IS PREPARING BREAKFAST

She grinds the corn on a flat stone called the *metate,* and makes large flat sheets of bread which are never brown—tortillas. The American prefers the *totoposte,* or crisp variety.

Photograph by Clifton Adams

MEXICAN DELICACIES IN THE MARKET OF TEHUANTEPEC

The repulsive-looking iguanas have clean, white flesh, which, when fried, is much preferred to beef or chicken by the Indians. It is the cruel practice among the women, who sell the reptiles alive in market, to break their backs in order to prevent their escape. The more humane venders merely tie the legs and mouths.

dances just above the strong, bare feet. The coquette may add a bracelet or two, or a gold chain may emphasize the depth to which the neck of the *cotón* (chemisette) has been cut. Add the half of a shallow gourd, sometimes two feet wide, painted and embossed in green and red and black until it seems to shine almost with Chinese lacquer. In these gourds, set on their heads, they carry everything (see illustrations, pages 568 and 569).

MOTHER AND NURSING BABY SMOKE TOGETHER

The nursing baby comes to the market place in a gourd on his mother's head. Sometimes the nursling is three or four years old, and after mother has nourished him he squats naked on the curb and he and mother smoke their cigars together. One hardly ever gets used to the extent to which domesticity is practiced in Mexico.

The *lavanderas* carry the wash in their gourds, the snowy twists piled high, and walk with an undulating certainty that only a lifetime of head burdens could grant. The market women tote pyramidal loads of melons and vegetables and the unescapable tortilla rides to the plaza in stacks two feet high, lightly covered by white cloths.

Always the laughing eyes of the women seek those of the stranger, and the red lips part to show the white teeth. The camera does an injustice to the beautiful women of Tehuantepec. It emphasizes the fact that they are Indians, brown-skinned and sturdy-waisted, and fails to

Photograph by Clifton Adams

A SMILE STIMULATES A SALE

Photograph by Clifton Adams

THE "MERRY WIDOW" VARIANT AT TEHUANTEPEC

The señora is utilizing the shade of a large basket, as she mixes her dinner menu in the corner of the market.

register the qualities of spirit and courage and sprightliness that make them beautiful. It can not truly depict their proud carriage or the floating ease of their walk or the coquetry in their black eyes. They know they are beautiful, for they have been told of it for generations. They are confident, yet not bold.

The Tehuantepecs are of the Zapotec tribe which was once the suzerain of this southern country. According to Zapotec tradition, which may or may not be relied on, they built the fortress of Mitla,* six days' ride westward by mule and a constant puzzle to archeologists. Not far away is the ruined city of Guerenguela, which once sheltered thousands behind its fortifications and is now but a heap of tumbled ruins. The Zapotec tradition is one of battles, just as for generations their women have been known for beauty.

On feast days the women wear their dresses of ceremony. The chemisette is lace then, or silk of many hues. The headdresses which adorn them in gourdless hours become cascades of embroidery that descend their straight backs like the war bonnets of our own Comanche chiefs (see pages 570 and 571).

Not a girl in Tehuantepec but has such a dress put safely away, and there are few who do not own a necklace of gold coins, American by preference. The revolution was hard on such treasures, it is true, and one does not see them often. Many a Tehuana girl has buried her necklace until peace comes to stay.

As one marches toward the cup of dry and dusty hills in which the city is set, one becomes enamored of its beauty and serenity. It is not often that an oxcart rumbles over the cobbles in these days of depression. Sometimes a string of burros, their dainty hoofs tap-tapping on the stones, tramps by with the usual air of inquiring intelligence. One passes a school to hear the boys inside roaring out their lessons in chorus.

An old church bell sounds. Bright eyes look from between the jalousies of the old Moorish houses, of which the reds

* See "Hewers of Stone," by Jeremiah Zimmerman, D. D., LL. D., in THE GEOGRAPHIC for December, 1910.

Photograph by Clifton Adams

A SHY TEHUANA MAID

The little lady is seated upon the immense wheels of the type of two-wheeled carts used for heavy hauling on the Isthmus of Tehuantepec. The oxen are yoked to these heavy vehicles by the horns.

and blues and purples have been softened by two centuries of sun.

Utterly naked babies stand shameless in the doorways to inspect the wanderer, and along the sands of the Tehuantepec River, which flows, broad and shallow, between green fields, are brown and rounded women at their daily bath.

Salina Cruz is a confession of failure written in dust and wind. It is a scattering, arid, sandy desert of houses in which the two or three hotels are lonely oases.

The white-hot sun beat upon the reaches of dry, loose sand. An oxteam or two dragged creaking wagons languidly toward the huge docks, on which $40,000,000 had been spent and at which four or five small vessels were loading coffee. Once this port bustled with business. Before the Panama Canal was opened, merchants transshipped east- and westbound goods here rather than make the long voyage around Cape Horn. Then every one had money. One can see sig-

nificant evidences of the former prosperity in two or three substantial buildings and the manner in which the town was laid out.

THE RISE AND FALL OF THE TRANS-ISTHMIAN RAILWAY

Even before the Panama Canal was opened, the goose which was laying the golden eggs had been discouraged, according to business men. Goods boxes were robbed or disappeared entirely. Sometimes the robbing was done at the docks, but not often, for there white men ran affairs with strong hands. But on the forty daily freight trains—twenty each way—the Mexican crews did as they pleased. They dumped boxes and bales into the jungle to be dealt with later by their confederates.

Customs officials proved hard to deal with and the shippers were discouraged.

Some of the war-made business came Tehuantepec's way, but not much. Just how much no one knows, for the statistics are unreliable even when they are get-at-able.

The Indian market was the one place in Salina Cruz in which animation could be discovered. The Indians chattered, bought centavos' worth of food from pots smoking over hat-size fires, chaffered over bargains, laughed at the intruding stranger, slept in the sun.

The iguana saleswomen had broken the backs of their stock in trade to keep them from running away. Some of the more merciful of the market-women had twisted the forelegs of these ugly lizards over their backs and lashed them together with withes. There are enthusiasts who insist that the meat of an iguana is white and sweet and tender, but after experiment it seemed to me more to resemble the leathery carcass of an old hen.

There were parrots for sale, and the skins of tigers, and now and then a coatimundi, which looks like a raccoon with an elongated snout.

There were no banks in Salina Cruz. Now and then a merchant needs an American credit and will buy bills or bank drafts, but for the most part they decline dealings with the Gringo. I ventured into two or three stores to announce that my stock of gold was running low, and that I would like to replenish it. The storekeepers did not even flatter me by interest. They merely said that they had no gold, and that my plight did not touch their hearts. If it were not for the foreign consuls, the stranger to Salina Cruz would find himself out of luck.

PUERTO MEXICO, ON THE ATLANTIC SIDE

We plunged again into the jungle on the way to Puerto Mexico, the Atlantic port of the railroad.

Puerto Mexico is the typical tropical water-front town. The streets are shoe-top deep in white-hot sand. Chickens pant for breath, undisturbed by a traffic that hardly exists, lifting wings from their burning bodies. Mounted men help the occasional wagoner by ropes from their saddle horns.

At last I was reduced to sitting on the hotel veranda to watch the long streamers of dust blow off the parched land into the green river. Narrow dugouts were being perilously paddled against the tidal current, in which silly porpoises rolled over and over forever. My eyes were miserably drawn to the reddened insect bites on the puffy arms of the lady at the next table. Inside the long bar was the lazy click of pool balls and the rattle of dice.

The tired waitress assured a wanderer that no one eats fruit in the Tropics. "Bad for the estomac," she said.

Oil tankers churn up the river as far as Minatitlan, rolling waves into the water grasses and lilies, submerging the placid alligators that rest with their long snouts thrust over the branches of half-sunk trees. Clouds of black smoke pour from the stacks of the refinery town. There are royal palms, and troops of little monkeys scold each other through the vines.

At night one sometimes hears weird screams from the dark wood. The man from an ordered, disciplined, kindly countryside resents the brutal heat, the furious growth, the savage morasses of the jungle. And yet one leaves with a feeling of sadness.

Photograph by Clifton Adams

HER NECKLACE, EARRINGS, AND FAN ARE HER PRIDE

The Tehuana girls wear heavy gold jewelry, the twenty-dollar gold piece of United States currency being a favorite article of adornment (see text, page 576).

OUR MAP OF NORTH AMERICA

THE National Geographic Society presents to its members as a supplement to this number of their Magazine a new Map of North America in six colors, the ninth in its series issued since February, 1921, as supplements with the NATIONAL GEOGRAPHIC MAGAZINE.

Those previously issued as parts of The Magazine were the New Map of Europe showing the changes in boundaries made by treaties following the World War, the New Map of Asia, the New Map of Africa showing the mandated colonial areas, the New Map of the World, and maps of South America, of the Islands of the Pacific, of the Countries of the Caribbean, and of the United States.

The Society has distributed among its members, who now number 900,000, a total of 10,476,000 copies of these maps. They have been received with remarkable enthusiasm, not only by members of The Society, but by map experts throughout the world and officials in many branches of the United States Government, and especially in schools and colleges throughout the Nation.

More than a year has been devoted to the compilation of the data for and the engraving of this Map of North America, which represents an outlay of $50,000, and has special features which no previously published map of this continent shows.

More place names in the Polar regions are given and the islands to the north of Canada are shown in more detail than on any other single map sheet.

Special care has been taken to show in great detail the coast of Alaska, so that when American aviators essay their deferred flight to the Pole their bases may be readily identified.

The Canadian portion of this map incorporates the latest information compiled by the Canadian Government, including recent surveys made in little-known portions of the Dominion, and appreciative acknowledgment is here made to the Department of the Interior of the Dominion for its valued coöperation.

In order that the Map of North America might be free from the usual distortion attendant upon showing any large portion of the earth's surface, the Chief Cartographer of the National Geographic Society devised for this map a special projection which gives the true direction and true distance from the center of the map to every other point. This projection is intermediate between the conformal, which has scale errors, and the equal-area projection, which has distortion of form.

The general elevation of the land is shown in flat colors, as on other maps of The Society, but in addition a special hachure plate is here used to show the general trend of the mountain ranges, thereby greatly improving the topographic aspects of the map.

The more important railroads, particularly the transcontinental lines, have been shown, but the automobile and park-to-park highways and the location of our National Parks and Monuments and other features may be studied in greater detail on The Society's Maps of the United States and of the Countries of the Caribbean.

Additional copies of the Map of North America may be obtained from the headquarters of the National Geographic Society, in Washington, D. C., at $1.00 each, for the paper edition, or $1.50 on linen, mailed postage free in the United States; foreign postage, 25 cents additional. Other maps of the series are available at the same prices, with the exception of the Map of the Islands of the Pacific, which may be obtained in paper for 50 cents and on linen for $1.00.

Notice of change of address of your GEOGRAPHIC MAGAZINE *should be received in the office of the National Geographic Society by the first of the month to affect the following month's issue. For instance, if you desire the address changed for your July number, the Society should be notified of your new address not later than June first.*

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EXPLORING THE MYSTERIES OF PLANT LIFE

By William Joseph Showalter

Author of "Exploring the Glories of the Firmament," etc., in the National Geographic Magazine

ALL the factories, all the railroads, all the mines, all the automobiles, all the activities of man of whatsoever nature that require power, do not utilize as much energy as is developed by the plant world.

Out of intangible sunshine, insubstantial air and clear water, coupled with a modicum of mineral matter from the soil, plants must manufacture all the food that keeps alive the innumerable hosts of animals of the earth, store up all the heat that keeps humanity warm and cooks its food, furnish most of the power that drives its industries, and provide the raw material for all the clothes mankind wears and many of the products of which his factories, his houses, his furniture, and his books are made.

Would you know how much of a plant is fabricated of sunshine, air, and water, and how little of solids from the earth? Then burn that plant and notice the thin layer of ash remaining. All else has been made up from subtle sunbeams, thin air, and plain water.

Every plant, from a simple moss to a giant tree, is in reality a vast household of individual entities working together, in fine coöperation and close harmony, to a common purpose. One group pumps up the water required by the community, which is carried to the points where it is needed by another group.

Others, respectively, obtain the solid food from the ground, mix it with air, sunshine, and water to make a substantial dish; carry the food to the various parts of the household; store up the leftovers; build additions to the house; and prepare to send out colonies from the parent rooftree, fully "grubstaked" and equipped to gain a foothold wherever they may settle down.

One observer sees the individual plant as a counterpart of a busy little city, teeming with life and bustling with industry. Here goes on the pulling down and building up characteristic of progressive communities; the streets and alleys are thronged with workers; here are dairies and milkshops dispensing their supplies; jewelers' shops preparing crystals; sugar refineries manufacturing sweets; starch factories storing foodstuffs; perfumers' laboratories distilling scents; varnish-makers developing resins and waxes; color establishments preparing dyestuffs.

DIVERSITY IN SIZE, FORM, AND HABIT

As diverse in their form as in the activities of their cells, the plants and flowers of the world exhibit every gradation in size from the big Sequoias of California and the great Eucalyptus of Australia to the tiny germs of tuberculosis and the microscopic bacilli of typhoid. They show every variation of form from graceful trees and airy blossoms to unfashioned slime molds and unorganized fungi.

They reveal every combination of color from the deepest red to the richest violet. They present every kind of texture from

Photograph by Harry F. Blanchard

FLOWER SECRETS

the ivory-hard seeds of palms to the jelly-soft fronds of seaweeds. They disclose habits that range from bold and beautiful independence to insinuating and crass parasitism.

The ability of plants to live and work under adverse conditions and to adjust themselves to their environment is one of the marvels of creation. Some two hundred thousand species have been catalogued and described, and they have adapted themselves to every conceivable sort of environment.

Some live in water, others in desert places; some rejoice in eternal sunshine, others prefer polar cold; some choose the seashore, others select the mountain peak; some thrive on thin air, others dwell in caves; some inhabit the human body, others have learned to thrive even where air is entirely absent. Some, indeed, find hot springs to their liking, and others begin to cover a new volcanic lava flow almost as soon as it ceases to glow.

Dependent on outside agencies for fertility, they call the winds to their service, enter into reciprocal relationships with insects, and develop devices of a high mechanical order.

Rooted to the ground, they are, next to man, the world's most eminent colonizers, drafting the winds, the waters, birds, animals, and even man into their schemes of dispersal.

Unable to run away when attacked, they have set up innumerable forms of defense for their protection, such as the thorns of the rosebush, the prickles of the thistle, the acrid juice of the golden-rod, and the poison of the mountain-laurel.

PLANT ANIMALS AND ANIMAL PLANTS

Kinship between animals and plants is so close that one finds between their respective kingdoms a twilight zone where animals are so nearly plants and plants so nearly animals, that biologists speak of plant animals and animal plants.

Even in their respective responses to outside influences, this close kinship is attested. Touch the eye of a frog and the eyelid closes; touch the hairs of a Venus flytrap and the leaf closes. Etherize the frog and the leaf and neither the frog's eyelid nor the flytrap's leaf will close. Remove the ether and both will recover their sensibility.

The varied and ingenious methods by which the flowers reproduce their kind and maintain the life of their several species, while the individuals die, are of paramount interest.

There are some plants, such as bacteria, which multiply by simple division. Others develop bulblets which take root and grow, like the lilies. Still others develop suckers, runners, and stolons, as in corn, strawberries, briers, and the like.

FLOWERS NOT PRIMARILY FOR OUR PLEASURE

But sexless reproduction is the exception and not the rule. Most plants are reproduced by "setting seed," and these always have flowers.

Once it was thought that these flowers were made chiefly, if not wholly, for the pleasure of human senses. To-day we know that the manifold varieties of floral forms we see are mainly devices developed by the plant to secure the perpetuation of the species.

They must protect their tender stamens and pistils; they must attract the insects that serve them and compensate the service; they must repel the insect "spongers" who would live at their board and render no service. They must employ other vehicles to secure fertilization.

It is to meet these conditions that the flowers have developed the calyx, or bud covering; the corolla, or petal series, and all the other parts of the blossom in the infinite variety of design and arrangement that we know.

"A living machine for making seeds," the flower has been called, and the essential parts of this machine are pistils and stamens. To fertilize the ovules of the pistil with the pollen grains of the stamen, and thus to start the "promise of the plant that is to be," is the flower's problem.

Less virile flowers, possessing both stamens and pistils, fertilize themselves. More progressive ones, also having both stamens and pistils, scorn self-fertilization, and in others the sexes are so separated that stamens and pistils occur in different flowers or even on different plants.

Some of these employ the wind and

DESPOILING A DOGWOOD TREE

The wild flowers are gradually retreating before the persecution of the city dwellers, which has been intensified and extended by the advent of the motor car.

© Ernest L. Crandall

LOADING DOWN A CAR WITH WILD FLOWERS

Many communities are organizing wild-flower preservation societies to save the flowers of much-frequented woodlands from extermination at the hands of those who ruthlessly destroy them after this fashion.

© Asahel Curtis

FLOWERS AROUND REFLECTION LAKE, MOUNT RAINIER NATIONAL PARK

The little protoplasts that build the myriads of cells which constitute a plant are all as much alike as peas in a pod; but some of them build roots, others stems, others leaves, and still others flowers. They divide their labors as systematically as the best human community.

the water as messengers for carrying pollen from mature stamens to receptive pistils. Such flowers are rigid economists except in the matter of pollen, of which they are profligate spenders. Insects might be attracted by pleasing odors, bright colors, and sweet nectar, but the wind and the water pay no attention to such things. So color, scent, and sweetness are absent.

But there is greater need for pollen, since wind and water are poor messengers and must be loaded down if any of the pollen is to reach its proper destination.

THE WATER PLANTS' PROBLEMS

Some of the water-fertilized plants have had to adapt themselves to fertilization under water, and hence have provided themselves with pollen of the same specific gravity as water. Others must be fertilized at the surface, and these launch their pollen grains on floating rafts. The water-living grass-wracks pro-

Photograph by Martha Bunting

A COW-PARSNIP BY THE ROADSIDE (IN THE RIGHT FOREGROUND)

Photograph by Loyd Cooper

DESERT FLORA IN CALIFORNIA

Nowhere do plants more clearly illustrate their adaptation to environment than in the desert. With their fight for existence so bitter, they must go the limit in protecting themselves against animals. Distasteful secretions are unusually abundant in desert plants and spines and prickles the rule. Some, like the living-rock cactus, even employ the art of camouflage to protect them from the animal allies of drought.

Photograph by Mary Beal

WHITE SUNDROPS AND PINK ABRONIAS ON THE MOHAVE DESERT, CALIFORNIA

In man's laboratories a temperature of about 2,400° F.—enough to melt pig iron—is required to separate the carbon and oxygen atoms of the carbon dioxide molecule. The plants, in their little cell laboratories, are able to separate them without difficulty.

duce pollen grains that become threads after leaving the anthers.

When the water-living tasselgrass matures its pistils and stamens in separate flowers, their stalks suddenly shoot up to the surface of the water, no matter what the depth, and the staminate flowers there spread their pollen abroad.

But the most interesting of all the water-living plants in the matter of fertilization is the familiar wildcelery. The female flower raises its head to the surface on a long stalk, but the male flowers remain entirely submerged until the time for fertilization comes. Then their buds detach themselves, float to the surface, and curve back their sepals, so as to make a raft for their two perfect stamens. These float about until they meet the female flowers.

Once the female flower is fertilized, the flower stem contracts and the flower is drawn beneath the surface, where it matures its seeds.

The wind-pollinated plants include many of the forest trees and most of the grasses. The pines with their cones, the hazels with their lamb's tails, the broad-leaved docks and the ordinary sheep sorrel with their pendulous flowers, the plantains and sedges with their scapes, the rye with its beard, are examples of wind-pollinated flowers.

A little farther up the line of floral development we find species of plants in the very stage of transformation from wind-lovers to insect-lovers—from anemophilous to entomophilous plants, as the botanists would say.

The flowers that are insect-lovers are

usually beautiful, fragrant, and sweet, for they must appeal to the insect's senses of sight, smell, and taste.

FLOWERS ARE DELIGHTFUL HOSTESSES

They make fine hostesses. As one writer has charmingly put it, they not only decorate their houses in delightful colors, perfume the palatial walls with gracious scents, and powder their pretty faces with golden pollen, but, accepting the ancient proverb that entertainment does not reach its climax until bread is broken with the guest, they provide rich viands of sweets.

However, they must be careful not to overfeed their guests, lest, sated, these would linger too long and not respond to the other invitations that are essential to carrying out the flowers' designs.

Likewise, they must bar their doors to the unbidden visitors that, unable to render service in return, would clutter the receptions and spoil their parties.

Photograph by Alexander Wiederseder

A FINE SPECIMEN OF THE CHAPARRAL YUCCA: CALIFORNIA

The story of the relations between the yucca plant and the yucca moth constitutes a marvel of biology (see text, page 592).

This problem is met in various ways. Many of the gentians use the opposite leaves to form collars to prevent the walkers from reaching the door. Others, like the snowdrop, hang their heads, so that the creeping creatures can't get in, and only the winged folk can call.

Some provide down-curving hairs along the stem, which form an abatis against the unwelcome guests. Some, like the verbenas, even place hairs on the flowers themselves.

Many of these unwanted guests are so persistent that they would steal in at the back door if they could, and some of the flowers thwart this maneuver with a swelled calyx that keeps the nectar safe, even if the walls are gnawed through.

Honeysuckles and similar plants constrict their corollas, so that only the insect with a long tongue can reach the sweets at its base.

Flowers like the toadflax and the snapdragon have masklike corollas, which close the door of the banquet hall to all visitors that have not the strength to push them ajar.

Sticky secretions along the stem and on the calyx form another device that some of the flowers, among them the catchfly,

Photograph by William H. Zerbe

IN THE GOOD OLD SUMMER TIME

Some plants seek dry places; others are waders that will not thrive if their feet are not in the water. With their likes and dislikes, they neglect neither the blistering desert, the snow-capped mountains, nor the boggy swamp, softening every landscape and cheering every prospect.

use to keep out the uninvited.

The tutsan-leaved dogbane, which is called the fly-gulper by the French, causes its stamens to nip the intruding flies by their proboscides, and to hold them tight until the insects die. Then the hold is released and the dead creatures fall to the ground.

PLANTS THAT MAINTAIN ARMIES

Some plants go still further in protecting themselves. They provide little crystals of sugar on the exterior of the flower, of which certain species of warlike ants are very fond. This enables the plant to maintain a garrison of defenders, and woe betide the beetles that would gnaw its nectar cups!

About three thousand species make such provision for the maintenance of standing armies. Some of the acacias go even further than this, actually providing sentry boxes in the shape of hollow thorns for their defenders. They also prepare, in addition to the sugar, little bodies of albuminous matter at the tips of the leaflets, which serve the ants as food.

Orange-growers in China and fruit-growers in Italy make use of this relationship between ant and plant by establishing ant hills at the bases of their trees, thereby accomplishing the results we achieve by spraying.

Cross-fertilization by insects has been said to produce a sort of floral aristocracy, with larger blossoms, brighter hues, sweeter scents, and richer nectar. Usually the guests come and go at will, but not always. Sometimes they are actually kidnapped and held prisoners until they have rendered their service — for a flower's invitation always has the string of obligation tied to it.

One of the birthworts, for instance, has hairs in the corolla which permit the ant or other creature to enter, but hold it prisoner until it has crawled all over the stamens and pistils, and is either loaded with pollen by the one, or has had its burden taken from it by the other. Sometimes the imprisonment lasts for as long as sixty hours.

The Dutchmans-pipe accomplishes the same object by making the tube leading

© Ernest L. Crandall

BLUE WILD-INDIGO FLOWERS AT BLACK POND, VIRGINIA

The struggle of the flowers to keep their nectar safe from robbers who do not serve them is as unrelenting as between the locksmiths and burglars of human society. Note bumblebee in blossom at left.

© Ernest L. Crandall

A VERMONT BULLFROG COMES OUT TO OBSERVE AN ARROWHEAD

to the nectar so smooth that the small flies entering it cannot get a foothold on the way out, until the flower withers.

Some of the orchids secrete a copious supply of nectar, which is poured into a little chamber that has an overflow spout to discharge the surplus. The bees visit the flower to gnaw the sweet, fleshy ridge within. In doing so, they frequently push their fellows into the nectar chamber, where they get involuntary baths and from which they can escape only through the overflow spout. This forces them to rub their bodies against the receptive stigmas, and thus leave with the latter pollen from a previously visited flower.

THE YUCCA AND ITS MOTH

The yucca moth and the yucca flower have formed a striking flower-insect partnership. When night comes, the female moth will be found busily engaged in visiting yucca blossoms and scraping the anthers bare of their pollen.

This she makes into a ball. When enough flowers have been visited to make the ball two or three times the size of her own head, she flies away to another blossom whose pistil has reached the receptive stage.

There, with her ovipositor, she makes an incision in the pistil, puts her egg into the cut, and then runs to the top of the stigma and rams the pollen into its funnel, which insures the setting of seed.

The mountain-laurel fastens each of its stamens down in a corresponding pocket of the corolla. When a bee visits the flower and treads around over the corolla in its task of draining the nectar cup, it steps on the stamens one by one. This releases them after the manner of a mouse springing a trigger trap, whereupon the stamen springs up and over the back of the bee, dusting it with the pollen in the anther.

Some flowers, like the milkweed, grip the legs of insect visitors and hold them fast. In trying to "yank" the trapped leg free, the bee pulls loose a little saddlebag arrangement, containing two packs of pollen, which adheres to the leg. Flying away to another flower that has a receptive stigma the insect leaves the saddlebags with it.

Not all flowers, however, attract their

Photograph by Mile High Photo Company

PONDLILY PADS ON SNOW WATERS, WILD BASIN, ROCKY MOUNTAIN NATIONAL PARK

Ganong, in his excellent book, "The Living Plant," reminds us that, in the dispersal of their seeds, plants employ methods analogous to man's ways of supplementing his legs. They build rafts that match his boats, employ animals as he rides horses, devise lighter-than-air craft and heavier-than-air gliders, use birds as airplanes, and even steal rides on his ships, his railroad trains, and his automobiles.

guests by fragrance and beauty. Some of them claim the attentions of the flesh flies, for instance, and affect a resemblance to decaying flesh, both in color and odor. The carrionflower and the skunk-cabbage are examples of this departure from the orthodox.

The arrangements by which flowers having both stamens and pistils prevent self-fertilization are of various types. Some, like the meadow cranesbill (*Geranium pratense*), mature their stamens first. The stigma does not develop to a receptive condition until after the stamens have discharged their pollen.

Others, like the introduced birthwort (*Aristolochia clematitis*), solve the problem the other way around, maturing their stigmas first and holding back their stamens until after the stigmas have passed

Photograph by J. Smeaton Chase

WHERE THE SANDVERBENA AND THE MESQUITE MEET IN CALIFORNIA

Many desert plants have learned to "make hay while the sun shines" by gorging themselves with water on the few occasions when rain falls and then guarding it, as a miser hoards his gold, while they fight their battles with scorching heat.

the receptive stage. There are other devices employed to accomplish the same end, each remarkable in its effectiveness.

COLONIZING METHODS EMPLOYED

That plants must send out colonies, though themselves rooted to one spot, is plain to all who give the matter a moment's thought. If they did not, they would finally reach a point of density and competition where few, if indeed any, could survive. Furthermore, the soil in many cases would become so exhausted that they would starve.

Still further, conditions are ever changing, and new and more favorable locations are ever developing.

Some plants colonize by powers of independent locomotion. For instance, the slime-molds—those unorganized masses of living protoplasm found in decaying wood, wet earth, or neglected flowerpot—creep along in a given direction precisely as does the amœba among animals. Some algæ develop spores possessing tiny hairs which vibrate and propel them through the water. Others have little flagellums that act like tractor propellers on an airplane in drawing them through the water.

Colonization through extension of growth is a frequent method employed by higher plants. The strawberry with its runners; the yarrow and the apple tree with their suckers; the mushrooms with their mycelial threads and fairy rings; the briers with their stolons, and the walking ferns with their fronds rooting at the tips, are examples of this method of colonization. So is the Solomonseal which grows underground year after year, the old parts dying as new ones are formed.

Of course, plants that send out runners cannot travel fast or far, and other means of colonization are demanded by those which seek to go great distances.

Seed expulsion is one of the improved methods of spreading a plant's domain. In the vetches the pods burst open, the two halves of the pod twisting in opposite directions. In the wild geranium the ripening styles suddenly curl up and burst open the seed box.

In the castor-bean, the witch-hazel, and the acanthus the valves of the capsules burst, shooting out the seeds. In the violet the slick seeds are caught between the two sides of the ripening pod, which squeeze harder and harder until the seeds are shot away, exactly as a boy shoots a bean by pressing it between his finger and thumb.

But all the mechanical arrangements by which plants and flowers send out colonies without outside help would come far short of the needs of the situation. They must enlist the aid of outside agencies, such as the birds, animals, and even man, to reach the far-flung positions so many of them aspire to possess.

One method by which they are able to command this service is by developing seeds with hooks, which cling to hair or feather or clothing. The seeds of the close-clinging burdock, the cocklebur, the beggar-tick, and the Spanish-needle are familiar examples.

Hooks are less efficient in holding on to feathers than glues, and, as might be expected, there are many plants that develop sticky seeds to insure transportation by the fowls of the air. Birds in this way often carry seeds hundreds of miles. The mistletoe berry and the twinflower are examples of plants providing their seeds and fruit with adhesive material so that they can use the birds as animated airplanes.

Other plants bring about the transportation of their seeds by animals either by developing seeds in edible fruits or edible kernels in hard shells. The peach and the blackberry are types of the former, and the hickory nut of the latter. Neither kind is attractive as food until the seed is mature.

ATTEMPTS TO DECEIVE

Some seeds seem actually designed to deceive animals and to procure their dispersal by fraud. Cow-wheat, for instance, produces seeds so closely resembling ants' eggs that many of them are found in ant hills. One plant produces a seed pod resembling a caterpillar relished by birds; another, a seed resembling a beetle.

Some of the castor-bean plants produce seeds resembling fat ticks. In all such cases it is soft-billed birds the plants seem to impose upon. Their seeds wouldn't have a chance of safely passing through the gizzards of the grain eaters.

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A DAYLILY ENTERTAINING A BUTTERFLY GUEST

Most of the weeds of America are of Asiatic and European origin. They have come as stowaways, and, after landing on our shores, have spread with tremendous rapidity. They have relied on man for their dispersal and have not been disappointed.

Water dispersal of seeds has been employed by many plants. The Hindu lotus, some of the waterlilies, and the coconut palm are examples of water-borne seeds. No matter what the geological history of the vast number of islets in tropical seas, their shores are fringed with coconut palms. With their great air-filled husks, the coconuts travel up and down the seven seas for months and years until they find a beach where they can get a "root hold."

Wind-dispersed plants are numerous. We see them resorting to all kinds of stratagems to command waftage by the winds. The parachute plume of the dandelion, the down of the thistle, the silky plume of the Virgins-bower, the soft tuft of the milkweed, are examples of the effective vehicles which carry seeds far and wide on the wings of the wind. The propeller-blade seed of the maple is another typical device utilized for seed dispersal.

Still other plants gain the aid of the wind by folding themselves up into balls and waiting for gusts to come along, uproot them and drive them to new habitations, scattering their seeds as they go. The Russian thistle and the rose-of-Jericho are characteristic "tumble weeds."

In Russia there is a plant known as the "wind witch," which has a root like a radish. When it matures the branches of the stalk curl down and pull up the plant, root and all. Then it waits for a high wind to rise and blow it away to some new location where it can take root again and begin a new career.

EACH PLANT BUILDS ITS OWN CELL CITY

The ways by which individual plants build their houses and do their work form a story no less fascinating than the methods by which the flowers hand their lives on to future generations, though they themselves are destined to perish.

The seed that finds its "place in the sun"

settles down and awaits the hour when propitious conditions of moisture and warmth shall awaken the germ of life that sleeps within.

Once this little speck of living matter is aroused in its tiny cell it becomes busy, sending out bits of itself to the neighborhood around it. Each of these promptly builds itself a tiny house of its own, with walls a thousand times thinner than the finest gossamer, but still constructed of microscopic bricks of cellulose, between the interstices of which the pioneering protoplasm can maintain connection with the parent cell, and at the same time reach out and start its own children to building other cells.

The size of these cells varies. A single cubic inch of fine cork may have as many of them as there are people in the world, yet each one has been built and inhabited by a protoplast, which has not only patiently thickened the wall of its house, layer by layer, but has also done its bit in the life of the community of which it is a part.

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A SPIDER WEB AMID COSMOS STALKS

The spiders often spread their webs in the paths of the guests going to the flowers' banquets.

When the microscope was first invented and philosophers peered into these little houses and saw the inchoate plasm within, amazement and awe possessed them. Jan Swammerdam, the great Dutch student, became almost insane at the marvels his lens revealed, and finally destroyed his notes, holding it a sacrilege to unveil and thereby profane the wonders hitherto beyond human ken.

The things the pioneers saw were considered delusions, until the members of the Royal Society of London peered through a microscope and jointly signed a paper saying they had seen these wonders with their own eyes.

THE "SILENT ROAR" OF THE VAST PLANT INDUSTRY

A somewhat viscid substance, not unlike the white of an egg, though thicker, the bit of protoplasm within a cell does the fundamental work of all organic matter.

Huxley, in speaking of the stirring activities of the busy little protoplasts, or individual bits of protoplasm that build their several cells and do their respective community tasks in a plant's activities, says: "The wonderful noonday silence of a tropical forest is, after all, due only

Photograph by Harry F. Blanchard

A YOUTHFUL GARDENER WATERING HIS PLANT CHILDREN

Water, water, water, and more water, is the demand of growing vegetation. Ground that gets less than 2,500 tons to the acre is semi-arid. Six thousand tons is about the normal annual rainfall per acre in the United States.

to the dullness of our hearing; and could our ears catch the murmur of these tiny maelstroms, as they whirl in the innumerable myriads of living cells which constitute each tree, we should be stunned, as with the roar of a big city."

And whoever has seen the radio receiving set catch the infinitely small impulses of electricity and amplify them into sounds that fill a loud speaker can appreciate his statement.

As it grows, the little community of protoplasts that build a plant divides its labors, and the complex activities of the growing flower begin.

The whole community of cells constitutes the plant, and through the delicate interstices of their walls the inhabitant of each communicates with those of all the other cells, so that the living substance of the entire structure is in constant contact and forms one united mass.

The building of their own tiny houses by the individual protoplasts is an immeasurable boon to humanity. Without these our plants and trees would never exist and all we would know would be masses of slime.

SIGHT-SEEING IN A DAISY

Let us reduce ourselves to the size of a molecule of water and ramble through one of these cell cities we call a daisy, noting the hustle and bustle and industry constantly taking place.

We promptly discover that one of the principal things going on is the manufacture, by the protoplasts, of a myriad tiny green grains which have been named chlorophyll. These grains have the power to screen out all the rays of light except the red and most of the blue, indigo, and violet series, which they use in their work.

Concentrating these useful rays on the stream of minute particles of carbon dioxide which come into the leaves through their pores or stomata, the chlorophyll breaks the carbon and oxygen apart and unites the carbon with water, which thereupon becomes grape sugar.

In man's laboratories it takes a temperature of 1,300° C., enough to turn the hardest steel into liquid, to separate the carbon and oxygen atoms of the carbon dioxide molecules exhaled by animals and absorbed by plants. But the little laboratories of the cell city do it without difficulty, and in so doing fabricate the basic food of all organic life, grape sugar.

To make a pound of the sugar, our guide tells us, the plant must work over nearly ninety gallons of carbon dioxide, in the extraction of which it has had to filter thousands of gallons of air. The sugar factory works from sunup to sundown, the eight-hour day being unknown there. But it operates only when the leaves are out.

A LEAF AS A FACTORY

How closely the sugar industry in the plant parallels the activities in a human factory is shown by the fact that the leaf corresponds to a building, the cells to the several rooms therein, the blue and red sunlight rays to the power employed, the chlorophyll to the machinery used, carbon dioxide and water to the raw material utilized, grape sugar to the manufactured product, and oxygen to the by-product.

As we move along we see a constant stream of carbon-dioxide particles rushing by, passing through the cell walls, where they meet the molecules of water. The chlorophyll grains turn their burning glasses with their red and blue rays upon the materials thus gathered into the retort, and grape sugar is formed.

After the chlorophyll grains have made the grape sugar, some new workers take it and transform it into starch, which is stored in cells for future use, just as the iron manufacturer converts his molten metal into pig iron, stores it, and melts it again when he wants to use it. A thousand square feet of leaf surface will manufacture one pound of starch in five hours of sunlight.

The action of plants in storing up starch closely parallels that of business men in accumulating estates. Just as the business man invests his funds so that they will be available for conversion into ready money if he needs it, so the plant puts by its earnings in the form of starch ready for reconversion into the coin of its realm, sugar, if necessary. And just as the business man bequeaths his estate to his children when he dies, so the plant transmits its surplus to its posterity when it passes.

AVALANCHE-LILIES IN SPRAY PARK: MOUNT RAINIER, WASHINGTON

The flowers follow the retreating snows in lofty mountains and high latitudes with a promptness that makes them appear to be armies pursuing an enemy.

Photograph by Curtis and Miller

FLOWERS THAT WILL NOT WAIT FOR THE SNOWBANK TO DISAPPEAR: MOUNT RAINIER NATIONAL PARK, WASHINGTON

Men and animals have learned to rob the plant of its savings and its children of their patrimony by eating things rich in starch.

A third material is made by the plant which is used in its building operations—inulin. It closely resembles starch, and is fabricated by another set of workers.

While all these manufacturing activities are going on in the cell city we call a daisy, sap must also be provided, for without rich supplies of moisture and a tiny bit of mineral substance the wheels of industry of the community cannot revolve.

So the roots act as pumps and bring into the city vast supplies of water with mineral in solution, in the proportion of a grain of minerals to a gill of water. This sap is pumped to every part of the plant and bathes the protoplasm of every cell, keeping the protoplasts moist and in high spirits.

THE RÔLE OF CELLULOSE

Out of the sugar, starch, and inulin fabricated by the three types of workers we have visited, other products are built, such as cellulose, which forms the microscopic bricks out of which the cell walls are constructed, and the fixed or fatty oils which are stored up in seeds, bulbs, etc., as reserve material for future exigencies.

As our guide leads us on through our daisy we see the cellulose being fabricated. The fibers of cotton, the pith of woody stems, and the filter paper of the chemist are familiar forms of cellulose.

The plant makes it serve a double purpose, now as cell-wall material, and now as a stored product that may be reconverted into sugar if needed for food.

As the cell ages, lignin may be added to give stiffness to the plant structure, making wood; other materials are employed to give hardness to the shells of nuts, waterproof character to cork, or gumminess to seeds like flax.

It is the cellulose of plants which lived long eras ago that we burn when we use coal to-day. Nature bottles up sunshine in it, so that every engine driven by coal is indirectly a solar engine, and every bit of warmth our fires afford in winter is the heat of summers millions of years past.

If we visited other plants and entered into their cell communities we would see them manufacturing the malic acid of apples and currants, the citric acid of lemons and oranges, the tartaric acid of grapes; the waxes which make some flowers, like the nasturtium, immune from wetting; the resins which salve the wounds of injured plants; the glucosides which make the wonderful hues of autumn, and the poisons which protect the plants and serve humanity, such as strychnine and morphine. Still other workers are building up the proteins or flesh formers.

But most interesting of all the products made by the plant, perhaps, are the enzymes. They convert sugar into starch and starch into sugar. They have been called the tools with which the protoplasm effects the chemical results it requires. Dr. Frederick V. Coville, the eminent botanist of the United States Department of Agriculture, has shown that it is the chilling processes of winter, and not the warm sunshine of spring alone, that cause the buds on the northern trees to open. He has described how they are driven out by the terrific forces released when the enzymes penetrate the walls of the starch cells and convert the starch into sugar.*

PUMPING UP A WATER SUPPLY

An examination of the machinery by which plants take in the raw materials out of which they fabricate so many marvelous substances reveals many interesting mechanisms.

Inspecting the seedling of a mustard, one finds that it has a slender root covered with a multitude of tiny hairs. At the end of the root is a growing tip.

If a potted plant is cut down to the surface of the soil and a glass tube slipped over the stump, it will be noted that the sap which would have flowed through the plant rises up in the tube to the approximate height of the original plant.

This sap consists of water and mineral matter drawn out of the earth by that strange process of Nature through which

* See "The Wild Blueberry Tamed," in the NATIONAL GEOGRAPHIC MAGAZINE for June, 1916.

Photograph by Ernest L. Crandall

MOUNTAIN-LAUREL GRACING THE BANKS OF A MARYLAND STREAM

the weaker of two solutions passes through a membrane separating them into the stronger.

The protoplasm acts as a membrane, and the water in the soil is drawn through it to join the sap in the root. As the volume increases the osmotic force drives the excess up into the plant structure.

The hairs of plant-roots are ever busy pumping in water. Through capillary attraction in the soil, particles several feet away are made to contribute their moisture to the hairs. A cubic foot of clay may have as much as three acres of particle surface exposed to the moisture drafts of a root system.

Between the water the plant uses in the manufacture of grape sugar and the much larger quantity it must pass through its system to keep the plants from wilting, heavy drafts are levied on the soil.

An oak tree with 700,000 leaves is estimated to give off 120 tons of water a season; an acre of grass has been found to give off more than six tons in a single day. From 200 to 500 pounds of water are given off by plants for every pound of dry substance manufactured.

SUCTION AND FORCE PUMPS

It has been estimated that if the rainfall during the month of July, in the corn belt of the Mississippi Valley, is one-half inch short of the three inches required to make a full crop, that half-inch shortage costs the farmer five dollars for every one of the millions of acres of corn grown in that belt.

The osmotic power in the plant is supplemented by other agencies to carry the water to the top of the tree. As a big tree must do the equivalent of carrying 500 bucketfuls of water up a ten-foot flight of stairs every ten hours in midsummer, one may judge how important the process is.

The chemical processes going on in the interior of a plant in the growing season develop considerable heat, just as the friction in an automobile motor makes it hot. To carry off the heat engendered in his engine by friction, the motorist employs a cooling system, with water caused to circulate in a radiator system.

The plant needs even more effective

cooling to keep down the heat of chemical change. The major portion of the water it demands is employed to keep its "radiator" full in order that evaporation on the leaf surface may reduce the plant's temperature.

Many plants have damper systems, whereby excessive radiation is checked, a method corresponding to our employment of hood covers and winter fronts on our automobile engines.

The mineral matter drawn into plants in solution is made available in many ways. The earthworms are allies of plant growth. It has been estimated that an acre of arable land contains an earthworm population of 130,000, and that they pass two tons of soil through their gizzards every season, converting it into humus rich in soluble minerals.

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A SONG SPARROW BUILDS HER NEST IN A MARYLAND ROSEBUSH

Lichens will eat into marble like acids in getting mineral material for their upbuilding. Different kinds of plants need different minerals—potatoes and turnips call for plenty of potash, wheat and corn for much silica, beans and clover for considerable quantities of lime.

PLANTS ADAPT THEMSELVES TO SURROUNDINGS

The manner in which all kinds of plants adapt themselves and their parts to their environment has long been a source of wonder to those who know the flowers best.

The leaves, whether on tree or flower or grass, always arrange themselves to command the required amount of light. Some flowers close at night and have been known to do so upon the approach of a shadow. Others will close if a red-hot poker be brought near to them. Odors offensive to them cause some flowers to close and even to die.

Insectivorous plants are largely an adaptation to environment. Usually those which prey upon insects grow in regions where nitrogen is scarce—mayhap in bogs and perchance in sandy, acid soil.

The traps of these plants are strikingly well suited for their work. The Venus flytrap's leaves stand open normally. An insect crawls in, and in so doing touches one of the three trigger hairs that project from the surface of each half of the leaf.

If the insect is worth while, the leaf shuts up tight and does not open again

Photograph by Ernest L. Crandall

OX-EYE DAISIES GROWING WITHIN THE SHADOW OF A SOUTHERN RED OAK AT ARLINGTON, VIRGINIA

The action of plants in storing up starch closely parallels that of business men in accumulating estates. The potato is mainly a savings account of starch, put aside by the plant for the benefit of its heirs.

© Ernest L. Crandall

A WASHINGTON WATERLILY GARDEN, WITH SWEET-SCENTED WHITE WATERLILIES IN THE FOREGROUND

The flowers build up proteins or flesh-formers, and some of them use as many as 15,000 atoms of carbon, hydrogen, oxygen, nitrogen, sulphur, and phosphorus in making a single molecule, which becomes a far more complex thing than an automobile or a watch. No wonder man has not been able to progress far forward in making synthetic plant products!

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AN ALBINO WOODCHUCK AMONG FERNS ON THE FARM ADJOINING PRESIDENT COOLIDGE'S FORMER HOME AT PLYMOUTH, VERMONT

until the flesh of the prisoner has been digested. But if it is such a small creature as a gnat or a tiny ant, the trap opens and lets the prisoner fall to the ground.

Once a sizable insect is caught, there is no escape for it. The more the insect struggles the tighter the trap closes. On the other hand, give the trap a stone and it soon releases its hold.

In setting its snare the flytrap is not content to wait for chance prey; it actually spreads bait for them, in the shape of a sweet secretion on the surface of the leaves. It is little wonder that Darwin called this "the most wonderful plant in the world."

The competition of plants is often a fierce race for the survival of the fittest. We see the climbing plants creeping up the trunks of giant trees, stealing the sun away from the latter's leaves, and often smothering or choking them completely. Many a fine tree has been killed by ivy plants robbing it of light.

There are many parasitic plants like the mistletoe, the dodder, and the broomrape, which have suckers that penetrate the bark of other plants and suck away their sap as leeches drink the blood of animals.

One often sees hazel and other stems looking like huge corkscrews; the deep spiral grooves have been caused by twining vines gripping the stem and preventing expansion along the spiral lines.

There is a group of plants known as Ficus, to which the fig belongs, whose seeds are deposited on the branches of trees by birds. Here they germinate. The roots clamber down until they reach the soil and the stems climb up until they reach the crown of the tree. Once thus established, the hitherto soft and tender aërial roots begin to harden and to throw out branches which flow into, and amalgamate with one another, until the tree trunk is girt about with a series of irregular living hoops. Ultimately the tree is killed by these strangler figs.

PLANTS ARMED FOR THE FRAY

But while competition is often fierce and the struggle for survival frequently bitter, many plants enter the conflict

Photograph by Ernest L. Crandall

A WATERLILY IS ALWAYS A THING OF BEAUTY

armed and ready to protect themselves against both plant and animal foes.

The latex of the rubbertree is not made to furnish man with automobile tires and raincoats, but rather to dress its own wounds. Does a woodpecker drill a hole in the rubbertree's trunk, the latex flows, and heals the wound. Does the beetle try to invade the cell city that constitutes the tree, it is made prisoner and duly executed. Does a mistletoe seed attempt to take root, the poisoned sap overpowers it.

As a protection against field mice, insect larvæ and other underground dwellers, many food-storing roots develop poisonous and disagreeable substances in their tissues. Sometimes these take the form of alkaloids and fetid gum resins. The soapwort, the rhubarb, the monkshood, and some of the gentians use this method of defense.

The close approach of some of the flowers to what men conceive to be intelligence has been noted by many authorities. One of them pinned a live fly on a bit of cardboard half an inch from the leaf of a sundew. In two hours the leaf succeeded in approaching the insect and fastened its tentacles about the creature.

The evolution of plants and the development of cell communities form one of the most fascinating stories in Nature. Originally they were undoubtedly one-celled structures, some of which still survive in our times. All the varied functions of a plant thus had to be performed by a single cell.

Then, coming out of the water and upon the earth, they needed to be rooted to the spot from which their nourishment would come, and roots began to develop.

Step by step, life requirements became more complex and new conditions were met by the creation of specialized cells which could do a definite task, and the plant was gradually transformed into the complex creation that it is, largely along lines paralleling the development of peoples from simple families to highly organized communities.

We encounter plants in all stages of this rise from the one-celled primitive to the intricate modern, to-day. When they first appear, the leaf bud and the flower bud are indistinguishable. In the white

waterlily the gradual stages of the transformation from the green sepals of the calyx to the yellow pollen-producing stamens may be studied, showing that the processes of evolution have gone on.

Jean Henri Fabre's account of the evolution of the cabbage is a classic picture of what the plant breeder's art—which is only an intensification of the slow and patient methods of Nature—may accomplish in the evolution of plants.

OTHER WONDERS AWAIT YOU

One might go on indefinitely, rambling through the plant world and discovering new thoughts that thrill at every turn. The bacteria, the molds, the yeasts—each of the thousand and one groups which represent departures from the original household has a story to tell.

But this is an introduction to the marvels of plant life, and not a treatise on plants. In the biographies of the individual plants in the accompanying flower series, many additional fascinating facts are brought out.

In their natural colors the flowers can tell their own stories of structure better than any words could, so that the descriptive text is left free to tell the story of their life problems, and the fine ingenuity with which they solve them.

GROUND-IVY

Glecoma hederacea L. Mint Family [Plate I, left]

This little immigrant from Europe has shown itself to be a great colonizer, and has established itself as far north as Newfoundland and Ontario, as far west as Oregon, and as far south as Georgia. It has a vast array of vernacular names, among them, alehoof, cat's-foot, gill, gill-ale, gill-over-the-ground, gill-go-by-the-ground, hayhofe, haymaids, tunhoof, creeping Charlie, robin-run-away, crow victuals, etc.

Its "gill" names are a survival of its European antecedents. There, its leaves were long used in the processes of fermenting and clarifying beer. The name is said to originate from the old French word *guiller*—to ferment or make merry.

The ground-ivy's preferred habitat is shady waste places, and its flowering season runs from early March to June. Grazing stock dislike its taste.

Among the cousins of the ground-ivy are the bugleweeds, the woodsages, the pennyroyals, the balms, the skullcaps, the hoarhounds, the dragonheads, the hyssops, the selfheals, the wildbergamots, the sages, the hedge-hemps, deadnettles, the peppermints and spearmints. The foliage of most of the members of this family is dotted with small glands containing volatile oils, upon which depend the aromas of the various species.

PITCHERPLANT

Sarracenia purpurea L. Pitcherplant Family [Plate I, middle]

Flourishing in peat bogs from Labrador to Florida and westward to the Rocky Mountains, the pitcherplant has the range of vernacular names characteristic of those flowers which invade widely distributed communities. Huntsman's-cup and whippoorwill's-boots are among its local aliases. Adam's-pitcher, fever-cup, small-pox plant, fly trap, and side-saddle flower are other names it sometimes wears.

The flowering season of the pitcherplant occurs in May and June. The blossom is striking. Its petals are of a deep, reddish purple, sometimes partly greenish or pink, and the style possesses an umbrella-shaped yellowish dilation.

The leaves at the base are hollow and cuplike, reddish and green outside, and pale-green, streaked with crimson inside. They are broadly winged and hooded, and become partly filled with water. Insects flock there to quench their thirst, or are attracted by the raw-meat appearance and decaying odor. The footing is very insecure, however, and many of them terminate their adventure by slipping helplessly into the water and drowning. In order to prevent the victims from escaping, the leaves are provided with a bristly surface, the hairs of which point to the bottom of the cup, and thus prevent the prisoners' exit.

The insects caught in the pitcherplant's ingenious trap, finding escape impossible, soon give up the struggle and die. The plant seems to have more need of nitrogen compounds than most flowers, and these it draws from the decaying bodies of the imprisoned insects. Several hundred species of carnivorous plants have been found in the world.

PALE WILDBERGAMOT

Monarda mollis L. Mint Family [Plate I, right]

The pale wildbergamot is one of those flowers that has found hospitable environment in many places, having reached British Columbia in Canada and Texas in the United States. Its favorite habitat is in dry soil areas. The magenta shade of its blossom makes it a favorite with the butterflies; the ruby-throated hummingbird is also a visitor.

The bergamot mints are useful in the manufacture of perfumery, the essential oil being highly aromatic. The pale wildbergamot has

Photograph by Mile High Photo Company

A TRYSTING PLACE IN LOVER'S LANE: ROCKY MOUNTAIN NATIONAL PARK

In the manufacture of a pound of solid matter, a tree or a plant must evaporate from 200 to 500 pounds of water to carry off the heat generated by the chemical reactions required in the process (see text, pages 599 and 601).

Photograph by J. Horace McFarland Co.

MERTENSIA, OR VIRGINIA BLUEBELLS, CARPETING A WOODLAND

Some of the smallest plants known are so minute that they make the typhoid and tetanus bacilli, which are invisible to the naked eye, seem large in comparison. One of these ultra-microscopic plants would find more room in a drop of water than would a fish in New York harbor.

many more or less distant cousins, among the closest being the beebalms. Spearmint, peppermint, mountain-mint, and catnip are cousins a little further removed.

Some members of the mint family have been so thoroughly domesticated that they grow well under cultivation, though they levy such a heavy tax upon the land that a crop rotation is required, with only one crop of mint every five years. In reclaimed swamp land they are sometimes allowed to grow for five years without change. The mint is mown like clover and cured like hay. The oil is usually extracted by passing live steam through the mass of cured material; this steam carries the essential oil with it, and on being condensed, the oil and water separate, after which the mint crystals form in the oil.

WILLOW AMSONIA

Amsonia tabernaemontana Walt. Dogbane Family [Plate II, left]

This representative of the dogbane family is a midsummer flower, with a range extending from New Jersey to Illinois and from Florida to Texas. Starting out as a hairy-leaved youngster, on reaching maturity its foliage becomes as smooth as ivory. It blossoms from April to July. The corolla tube is hairy inside.

Some of the other members of the family are the periwinkle, the climbing dogbanes, and the Indian-hemp. Most of the members of the family secrete an acrid, bitter juice.

The dogbanes are distantly related to some of the various plants yielding rubber. The Pernambuco or Mangabeira rubber of commerce,

indeed, comes from a member of the dogbane family itself, a small drooping tree which yields an edible fruit known as "mangaba," for the sake of which it is cultivated in many Brazilian orchards.

Some species of dogbane produce a root bark which has emetic, diaphoretic, and tonic properties. Some species in the western part of the United States furnish a fine, strong, long, and easily separated fiber, which the aborigines use in their textile manufactures.

COMMON CATTAIL

Typha latifolia L. Cattail Family [Plate II, middle]

Almost everyone is familiar with this cosmopolite of plantdom that has found America so much to its liking. It prefers the damp, moist richness of the swamp and goes wherever marshy conditions prevail, except in the high latitudes. The name tells two parts of its story—*typha*, meaning a bog, and *latifolia*, meaning broad-leaved. It grows from 4 to 8 feet high.

Like all widely distributed plants, it rejoices in a large number of aliases, such as great-reed-mace, cat-o'-nine-tail, marsh beetle, marsh pestle, cattail flag, bull-segg, water-torch, and candle-wick.

The old Italian masters frequently painted the cattail in the hand of the Master, as a mock scepter, in their pictures of the crowning of the Christ with thorns.

PUSSY WILLOW

Salix discolor Muhl. Willow Family [Plate II, right]

Few American shrubs play a more charming part in our folklore than the dainty pussy willow with its downy catkins and greenish-brown bark. Inhabiting the damp borders of thickets or creeping down close to the water's edge along small streams, it awakens early to the call of spring, whether in Nova Scotia or Saskatchewan, Delaware or Missouri. Sometimes attaining a height of 12 feet, the pussy willow has a light, greenish-brown bark, usually tinged with red; but the smaller branches are of a deep reddish hue. The winter buds are purple. The catkins are usually well out before the leaves begin to appear. The shoots of the shrub develop roots in the water.

The willows are believed to be descended from some of the oldest flowering plants, in which the sexes were on different trees and the pollen was carried from the one to the other by the wind. To-day they are entomophilous plants, relying on the insects to be their messengers, and ready to pay them well for their services. Color and odor form the printer's ink with which the messengers are attracted by the male catkins, and pollen and nectar the coin of the messenger realm.

The bees are the busiest pollen purveyors for the pussy willow. The little Andrenid bees, a family whose members are only about half the size of hive bees, are its special visitors. They are well bearded, each hair being fitted with a row of barbs that cause pollen grains to adhere and be carried to the next flower.

The pussy willow has to serve another insect in a different fashion. A gallfly lays its eggs in its twigs and leaves, and in some way so stimulates the growing tissue that it develops a large series of overlapping scales, which are modified leaves. These, diverted from their normal purpose, are compelled to serve as a cradle for an enemy's offspring. They form conelike buds an inch or so long, and more than three-fourths of an inch in diameter. Cut one of these galls open at the proper season and you will find ensconced therein, "as snug as a bug in a rug," the sleeping larvæ of the gallfly.

CARRIONFLOWER

Smilax herbacea L. Smilax Family [Plate III, left]

By some botanists the smilaxes are classed as a genus of the lily family. Others consider them entitled to rank as a family, and so classify them. Perhaps the lily family would be very glad if at least the black sheep that is the subject of this sketch were pruned from its family tree.

The carrionflower has a range that reaches from New Brunswick to Manitoba and from Florida to Nebraska. Its flowering season is from April to June and its preferred environment, woods and thickets. As its unsavory name is matched by a disgusting odor, the bees give it a wide berth and flies are called in to serve as its messengers. Attar of roses seems no more pleasing to the human odor-sense than the carrionflower to that of its fly friends. John Burroughs declared it smells like the vent of a charnelhouse, and Thoreau compared it to dead rats.

The carrionflower does not keep up its evil ways to the end of its time. Having made a virtue of necessity by fitting itself to entertain the little green flesh flies, as soon as it sets seed it throws off its evil nature, and, dressing up anew, in resplendent autumn tints, offers fine little bunches of small, bluish-black berries to the birds. Here again it has method in its madness, for these birds carry its seeds to other points and thus enable it to colonize in new localities.

COMMON ST.JOHNSWORT

Hypericum perforatum L. St.Johnswort Family [Plate III, middle]

A cosmopolite, which came out of Asia with the races that marched westward and gave the star of empire its direction, the common St.-Johnswort has made Europe and America its own, except in the high latitudes where Jack Frost comes too early and stays too late for its well-being. Fields, waste lands, and roadsides are all to its liking in the matter of environment and it flowers from June to September, growing from one to two feet high.

The St.Johnswort is hard to extirpate. Its rank, rapid growth is highly exhausting to the soil, and this, of course, makes it a most undesirable alien.

Usually possessing sterile shoots about its base, the plant may be seen maturing seed capsules on some branches while there are petals of withered flowers, fresh flowers, and even buds on others. Under these conditions it is usually an unkempt, untidy-looking flower.

Secreting no nectar, the St.Johnswort appeals only to the pollen gatherers, and accomplishes cross-fertilization by that attraction alone.

Few flowers have gathered such a cluster of superstitions about them as this immigrant from Europe.

Gathered upon a Friday, in the hour when Jupiter comes to his operation, and hung upon the neck, it helps mightily to drive away all fantastical spirits, the peasants of Europe believe, and in accordance with that belief they hang it in the windows of their cottages on St. John's Eve to avert the "evil eye" and break the spells of the spirits of darkness. Girls believe that its leaves will decide whether or not the coming year will make them brides, and therefore if it flourishes when they plant it they consider its prosperity a happy augury for their future. In early times poets and physicians alike extolled its virtues, and an ointment made from it brought it the name "balm-of-the-warrior's-wound." It was also considered an efficacious remedy for melancholia.

Livestock learn to give the St.Johnswort a wide berth, as it is poisonous to them.

SMALL SPATTERDOCK

Nymphaea microphylla Pers. Waterlily Family [Plate III, right]

Belonging to that princely family of aquatic flowers which includes the stately *Victoria regia,* the imposing *Castalia gigantea,* and the famous lotuses of Egypt and India, the small spatterdock is a humble American plant citizen quite content with its simple station. Flourishing from New Brunswick to Pennsylvania and westward to Minnesota, it flowers in midsummer, with ponds and sluggish streams as its favorite habitat.

The waterlilies of this and allied genera, numbering about 40 species, are, in the case of the northern species, perennials having rootstocks imbedded in the mud. So long as the water is deep enough to prevent its freezing solid, these rootstocks are able to spend the winter unharmed.

AMERICAN BLADDERNUT

Staphylea trifolia L. Bladdernut Family [Plate IV, left]

The American bladdernut belongs to a family found in all parts of the Northern Hemisphere, but mainly in Asia. The species that is the subject of this sketch lives in moist woods and thickets from Quebec and Ontario to South Carolina and Kansas.

It is a shrub that grows to a height of 15 feet and blossoms in April and May. Its greenish-white flowers, arranged in nodding panicles, give the bladdernut its generic name, since they resemble the bunch of grapes called by the Greeks *staphyle.* Its specific name arises from the grouping of its leaves. Its common name was suggested by the inflated capsule and the hard-shelled seed inside.

In many communities the flower buds are used like capers in seasoning foods, and in some places the seeds are eaten. The European bladdernut, *S. pinnata,* is often imported by landscape gardeners and planted as an ornamental shrub.

VIRGINIA SPRINGBEAUTY

Claytonia virginica L. Purslane Family [Plate IV, middle]

Flourishing in moist woods from Nova Scotia to Georgia and from Saskatchewan to Texas, the Virginia springbeauty, with a stem length of 6 to 12 inches, has flowers so delicate that they shrink at the slightest touch of the human hand, and yet so hardy that they can make their spring début along with the hepatica, arbutus, and bloodroot. Their early coming has been celebrated in some sections by naming them "Good-morning-spring."

The flowers of the springbeauty are starry blossoms which are turned mostly in one direction. They expand only in the sunshine.

This flower will not waste her sweetness on the desert air for insect pilferers, or blush unseen in the night or in bad weather; she shuts up shop when the sun-loving insects that are her customers seek their retreats at night or in dismal weather, and will not open again until they venture forth to her mart. Thus she saves her nectar and pollen for such as are welcome guests at her board.

Mining and leaf-cutting bees, bumblebees, and numerous species of butterflies are the principal guests, though 71 species of insects have been noticed as visitors. Among these were droves of hive bees, 31 species of two-winged flies, and even the little spotted ladybeetle with a taste for pollen.

The springbeauty has long since put behind her the time when self-fertilization was her method of perpetuating her species. She matures her stamens and offers their pollen to her guests before the stigmas have attained their maturity, which makes them susceptible to fertilization.

The proud portulaca and the humble "pussley" are cousins of the springbeauty and share with her the trait of pouting when the sun fails to shine on them.

GOLDEN MEADOW-PARSNIP

Zizia aurea (L.) Koch. Parsley Family [Plate IV, right]

Blooming from April to June, in fields, meadows, and swamps, from New Brunswick to Saskatchewan, and from Florida to Texas, the golden meadow-parsnip is a member of one

GROUND-IVY
Glecoma hederacea L.
Mint Family

PALE WILDBERGAMOT
Monarda mollis L.
Mint Family

PITCHERPLANT
Sarracenia purpurca L
Pitcherplant Family

© F. G. M., 1923

Willow Amsonia
Amsonia tabernaemontana Walt.
Dogbane Family

Common Cattail
Typha latifolia L.
Cattail Family

Pussy Willow
Salix discolor Muhl.
Willow Family

CARRIONFLOWER
Smilax herbacea L.
Smilax Family

COMMON ST. JOHNSWORT
Hypericum perforatum L.
St. Johnswort Family

SMALL SPATTERDOCK
Nymphaea microphylla Pers.
Waterlily Family

© N. G. M., 1923

American Bladdernut
Staphylea trifolia L.
Bladdernut Family

Virginia Springbeauty
Claytonia virginica L.
Purslane Family

Golden Meadow-parsnip
Zizia aurea (L.) Koch
Parsley Family

European Barberry
Berberis vulgaris L.
Barberry Family

Yellow Woodsorrel
Xanthoxalis cymosa Small
Sorrel Family

American Bittersweet
Celastrus scandens L.
Stafftree Family

© N. G. M., 1923

Snow-on-the-mountain
Dichrophyllum marginatum (Pursh) Kl. & Garcke
Spurge Family

Blackberry-lily
Gemmingia chinensis (L.) Kuntze
Iris Family

Small Bindweed
Convolvulus arvensis L.
Morning-glory Family

© N. G. M., 1923

WOODBETONY
Pedicularis canadensis L.
Figwort Family

SWEETFLAG
Acorus calamus L.
Arum Family

COBAEA PENTSTEMON
Pentstemon cobaea Nutt.
Figwort Family

© N. G. M., 1923

Curly Dock
Rumex crispus L.
Buckwheat Family

Common Shootingstar
Dodecatheon meadia L.
Primrose Family

Black Swallow-wort
Cynanchum nigrum (L.) Pers.
Milkweed Family

© N. G. M., 1923

Common Moonseed
Menispermum canadense L.
Moonseed Family

Purple Coneflower
Echinacea purpurea (L.) Moench
Aster Family

Canada Wildginger
Asarum canadense L.
Birthwort Family

© N. G. M., 1923

Branching Bur-reed
Sparganium androcladum (Engelm.) Morong
Bur-reed Family

Goldmoss
Sedum acre L.
Orpine Family

Lizardtail
Saururus cernuus L.
Lizardtail Family

© N. G. M., 1923

Low Poppy-mallow
Callirhoe involucrata (T. & G.) A. Gray
Mallow Family

Sweet Gale
Myrica gale L.
Bayberry Family

Checkerbloom
Sidalcea malvaeflora (Moc. & Sesse) A. Gray
Mallow Family

© N. G. M., 1923

American Burnet
Sanguisorba canadensis L.
Rose Family

Trumpet Honeysuckle
Lonicera sempervirens L.
Honeysuckle Family

Withe-rod
Viburnum cassinoides L.
Honeysuckle Family

© N. G. M., 1923

Rose Pogonia
Pogonia ophioglossoides (L.) Ker
Orchis Family

Small Yellow Ladyslipper
Cypripedium parviflorum Salisb.
Orchis Family

Arethusa
Arethusa bulbosa L.
Orchis Family

Tawny Daylily
Hemerocallis fulva L.
Lily Family

Field Garlic
Allium vineale L.
Lily Family

Grays Lily
Lilium grayi S. Wats.
Lily Family

©N.G.M. 1933

Poison Sumac
Toxicodendron vernix (L.) Kuntze
Sumac Family

California Rhododendron
Rhododendron californicum Hooker
Heath Family

© N. G. M., 1923

CREEPING POLEMONIUM
Polemonium reptans L.
Phlox Family

SWEET-WILLIAM PHLOX
Phlox maculata L.
Phlox Family

ALFALFA
Medicago sativa L.
Pea Family

of the most versatile flower families in the world. This family embraces some 1,500 species, as diverse in appearance, habit, and quality as the Venuscomb and the waterpennywort; the sweetcicely and the button-snakeroot, the water-hemlock and the caraway, the coriander and the dill; celery and fennel; the plant from which we get asafetida and that which gives us anise.

This plant grows from 1 to 3 feet in height. It is a very common perennial which frequents the roadside throughout its territory. Collecting in many small clusters, the tiny flowers carry out the department-store type of advertising characteristic of the composite family, whose members include the goldenrods, the asters, the sunflowers, and the thistles. The stamens are prominent and the species of insects numerous. Many species of two-winged flies and small butterflies are regular guests at the golden meadow-parsnip's table, but only a few bees are attracted by its offerings.

EUROPEAN BARBERRY

Berberis vulgaris L. Barberry Family [Plate V, left]

The European barberry has been naturalized from Europe in the Eastern and Middle States and from there has spread to Canada and the West. It consists of numerous races and is variously known as the pepperidge-bush, the jaundice-berry, and wood-sour. Blossoming in May and June and bearing fruit in September, it grows from 5 to 8 feet high. Its preferred habitat is thickets and roadsides.

Though the flowers are small, they are decidedly resourceful in insuring themselves the full service of their insect visitors in securing cross-fertilization. In one respect the arrangement of the stamens and pistil suggests that of the mountain-laurel, but the stamens are not held back by little springs like those of the laurel. Those of the latter plant catapult their pollen onto their visitors, while those of the European barberry are endowed with life and motion and are able to move like the leaflets of a sensitive-plant. If the base of the filament be touched on the inside with a pin, the stamen promptly shrinks and draws in toward the pistil in much the same way as the sea anemone closes its tentacles when touched.

When a bee visits one of the new-blown flowers, it finds the six little stamens resting wide apart, against the several petals. Thrusting its tongue into the nectar gland, the bee touches several of the stamens, whose pollen chambers are open and ready to scatter their contents. As the stamens draw in they dust the head of the bee, which carries this pollen dust to the next flower it visits.

YELLOW WOODSORREL

Xanthoxalis cymosa Small. Sorrel Family [Plate V, middle]

The yellow woodsorrel flourishes in fields, thickets, and woods from Ontario and Michigan to Florida and Texas and is a native American plant. Its flowering season ranges from May to October.

Growing from 6 inches to 4 feet high, and frequently reclining on its surrounding vegetation, it belongs to a rather small family, most of whose members are tropical, but so closely related to the geranium family that many botanists group it therewith. The cloverlike leaves "sleep" at night or in cloudy weather and the seeds are projected considerable distances when the capsular fruit bursts open. The family gets its technical name from the sourness of the sap of its members, which is a quality arising from the oxalic acid stored therein. Cross-fertilization is accomplished through the agency of small bees and beelike flies.

Some of the woodsorrels familiar in eastern America, like *Oxalis acetosella*, are natives also of Europe and Asia and appear frequently in the paintings of Fra Angelico and Sandro Botticelli. Other species, like *Oxalis violacea*, are endemic to the New World.

AMERICAN BITTERSWEET

Celastrus scandens L. Stafftree Family [Plate V, right]

Flourishing in rich soil from Quebec to North Carolina, and from Manitoba to New Mexico, the American bittersweet prefers situations along the base of the mountains. It is variously known as the fever-twig, false bittersweet, Roxbury waxwork, and climbing orangeroot. The flowers, appearing in June, are tiny and insignificant. They are scentless, but have many small bees and beelike fly visitors.

The berries, appearing in September, just ahead of the frost, are in reality capsules, which divide into three parts, each part curling backward and exposing the scarlet aril within. The enticing color of the berries and their sharp flavor are good advertisements to hungry birds, which, eating them with gusto, carry their seeds many miles, and thus become agents in the starting of new colonies.

This woody, vinelike shrub grows to a height of 6 to 25 feet, climbing over trees and rocks, and furnishing a rich contribution to the riot of autumn colors.

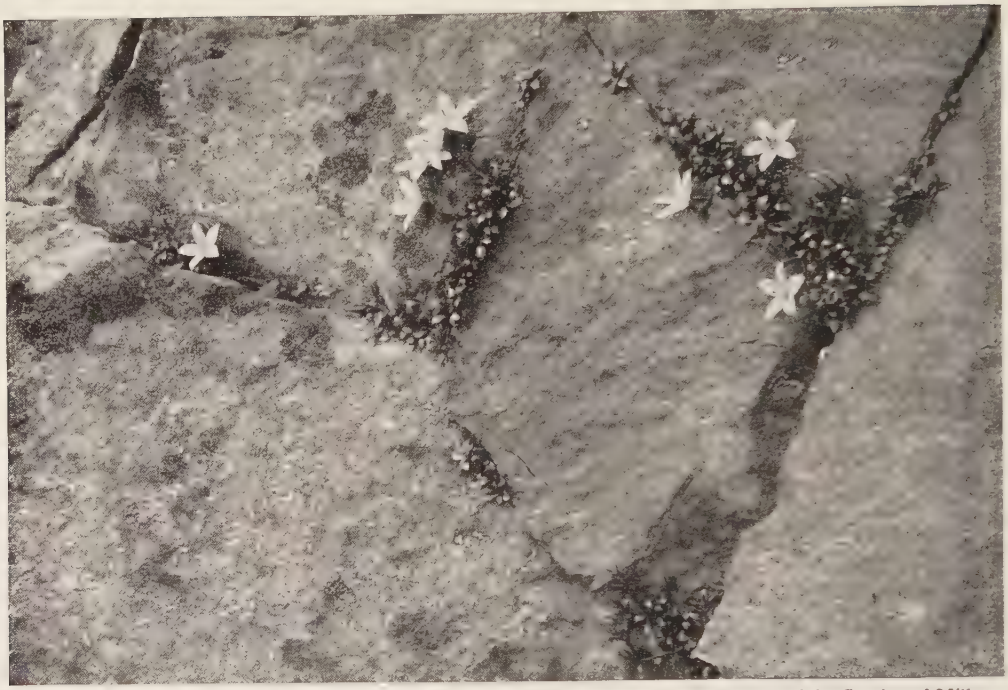
SNOW-ON-THE-MOUNTAIN

Dichrophyllum marginatum (Pursh) Kl. & Garcke. Spurge Family [Plate VI, left]

The spurge family, to which the snow-on-the-mountain belongs, is a vast one, made up of some 4,000 species, subdivided into some 200 genera.

The snow-on-the-mountain ranges from Minnesota to Colorado, in dry soil. It has been introduced into the Central and Atlantic States, where it thrives in waste places, from May to October, growing to a height of 3 feet.

The closest relatives are the seaside spurge, the milkpurslane, the copperleaf, the wartweed, and the moleplant, the last two having been introduced from Europe. More distant relatives include the tread-softly or spurge-nettle, the



Photograph by Curtis and Miller

A RARE HAREBELL FOUND ONLY IN THE OLYMPIC MOUNTAINS OF THE STATE OF WASHINGTON

Seeking out every little cranny and crevice in the rocks, plants often aid in their disintegration by their power to extract minerals even from stone.

croton-oil plant, the castor-bean and the candlenut.

Most of the spurge family favor a tropical habitat. Nearly every member of the family has an acrid juice, usually poisonous, but sometimes rendered bland by heating. Manioc starch comes from one species. From another is produced the highest-grade rubber that South America exports.

BLACKBERRY-LILY

Gemmingia chinensis (L.) Kuntze. Iris Family [Plate VI, middle]

The blackberry-lily is an imported flower which, escaping from flower gardens, has been able to fight its own battles and settle down to an independent existence on hills and along roadsides from Connecticut to Georgia and westward to Kansas. Its flowering season occurs in June and July, and it gets its name from the appearance of its fruit, which ripens from July to September. In some quarters it is called the leopard-flower.

Like many another flower that is a lily to the layman, this one does not belong to the lily family at all, but rather to the Iris family. It is truly an oriental, having come to the Occident from China.

The Iris family is a far-flung one. The most popular member, of course, is the French fleur-de-lis. Other members include the blueflags, the yellow Iris, and the dwarf Iris.

SMALL BINDWEED

Convolvulus arvensis L. Morning-glory Family [Plate VI, right]

Fields and waste places from Nova Scotia to New Jersey and thence across the United States to California are the favorite haunts of the small bindweed. It seems to have originally come out of Asia, moving thence to western Europe and then "beating its way" across the Atlantic in earth ballast or in packing grass. Among its aliases are the following: hedge-bells, bearbind, cornlily, withwind, bellbine, cornbind, sheepbine, and lap-love.

The family to which this plant belongs embraces about 1,000 species. Jalap and scammony come from two of them. The common sweet potato is the tuber of another. Two other species yield oil of rhodium and a wood powder which is used as a snuff and as an incense. Still another cousin is the common dodder, otherwise known as the love vine.

The flowering season begins in May and ends in September, and the small white or pink-tinged flowers are fragrant. The stigmas and anthers mature at the same time, but self-fertilization is prevented by having the pistils longer than the anthers, the former receiving pollen from a flower previously visited.

The bindweeds, both great and small, are a great nuisance to the farmer. A favorite trick of all of them is to use his stalks of corn as trellises.

© Fred H. Kiser

BEARGRASS IN ONE OF OUR NATIONAL PARKS

The lilies of the field seem not to toil and spin, yet they accomplish a work which makes that achieved by man, with all the noise, bustle, and roar of his factories and commerce, seem small in comparison.

Photograph by Ernest L. Crandall

THE MAYAPPLE (ABOVE) AND THE WILD STONECROP (BELOW) FORM A FOREST CARPET

WOODBETONY

Pedicularis canadensis L. Figwort Family [Plate VII, left]

The woodbetony flowers from April to June from Nova Scotia to Florida and westward to the Rocky Mountains. It has a preference for dry woods and thickets and in Virginia ascends to 3,000 feet elevation.

It belongs to a family that includes nearly 2,700 species, most of them possessing bitter juices and some of them yielding narcotic poisons. Among its cousins are the mulleins, the toadflaxes, the snapdragons, the figworts, the pentstemons, the turtleheads, the monkey-flowers, the hyssops, the foxgloves, the speedwells, the gerardias, the painted-cups, and the yellowrattles.

Vernacular names for the woodbetony include the following: high heat-ale, beefsteakplant, lousewort, and snaffles. It is a slightly hairy species. The four stamens are protected from the rain, or other pollen-destroying agents, by a hooded upper lip. Looking down on the tousled spike, it discloses a ripsaw symmetry. This is enhanced if the flower is plucked and twirled between the thumb and forefinger, the illusion becoming real and amusing. As the pansy reveals the face of an old man or woman, the woodbetony shows the head of a walrus, even to the spikelike projections resembling that animal's tusks. The flowers are so arranged that the bumblebee, their favorite guest, can quickly visit the whole group.

SWEETFLAG

Acorus calamus L. Arum Family [Plate VII, middle]

Though it is a cousin of Jack-in-the-pulpit and the skunkcabbage, the sweetflag or calamus has none of the insect-baiting habits of the former and none of the evil-smelling properties of the latter. Indeed, it has a record as an ingredient of incense that goes far back beyond King Tutankhamen, to times antedating the custom of burning incense by the people of Israel.

It is a cosmopolite, spreading over most parts of the North Temperate Zone and thrives in swamps and along streams. The pungent, though pleasant, flavor of calamus root is known to almost every boy.

The flowering time of the sweetflag occurs in June and July, the tiny, inconspicuous flowers completely covering a tapering, cylindrical spadix, growing out at a sharp angle to the flat stem. If these tiny flowerets be examined under a magnifying glass, it will be found that each one is a perfect little lily that has sacrificed much to live in the crowded community of the spike. Its six petals have been reduced to mere scales, each scale protecting a stamen.

The close crowding of the tiny flowerets has good reason behind it. The plant grows near the water, and hence must depend on tiny gnats, beetles, and other small members of the insect community for fertilization.

But even such teamwork does not suffice, for propagation takes place much oftener through the rootstocks than through the seeds produced

on the spike. When about half matured, the spike is tender and edible and the interior of the stalk is sweet.

The root of the sweet-flag has medicinal properties, and is used, when dried or candied, as a remedy for dyspepsia and as a stimulant and tonic for feeble digestion. It is powdered and used as an insecticide in India and Ceylon, and yields a volatile oil used in the manufacture of perfumery. The Greeks and the Babylonians knew of its properties and employed them both in medicine and in incense.

Photograph by Ernest L. Crandall

JACK-IN-THE-PULPIT BEGS ALL WHO VISIT HIS SANCTUARY TO "BE MERCIFUL" TO THE WILD FLOWERS

COBAEA PENTSTEMON

Pentstemon cobaea Nutt. Figwort Family [Plate VII, right]

This attractive member of the figwort family, which grows to a height of 1 to 2 feet, is essentially a Mississippi Valley resident. In the guise of cultivated flowers, varieties of this species have reversed the usual history of plant migrations and have crossed to Europe, where they are highly regarded.

Most of the species of the genus are western flowers, and only three species are found in the East. Flowering time comes in the late spring and lasts through the early summer, the plants being found mainly in dry, rocky regions, where they impart, when blooming, a peculiarly soft hyacinthlike effect to the landscape.

Penstemon cobaea is like most of the other species of the family in having a sterile filament that is bearded, and from this it gets its garden alias, the beardtongue.

CURLY DOCK

Rumex crispus L. Buckwheat Family [Plate VIII, left]

Like so many other plants that have the cuckoo habit of making others do their work, the curly dock is an undesirable alien stowaway from Europe. It fraternizes with the farmer's crops, and therefore succeeds in forcing him to prepare its bed and scatter its colonies, and has spread well around the world in the North Temperate Zone, invading every region where major cereals are cultivated. It grows from 1 to 3½ feet high, with a flowering season from June to August, and its wavy-margined leaves are replaced by heart-shaped seed-wings. It has been shown to hybridize readily with another species, the bitter dock, *R. obtusifolius*.

The buckwheat family, to which the curly dock belongs, embraces some 800 species divided into 40 genera.

More distant relatives of the curly dock include the mountain sorrel, the sheep sorrel, the knotweed, the smartweed, the princesfeather, the ladysthumb, the tear-thumbs, and the common buckwheat.

COMMON SHOOTINGSTAR

Dodecatheon meadia L. Primrose Family [Plate VIII, middle]

Growing from 8 inches to 2 feet high, in open woods, on moist cliffs and upon the broad

© Ernest L. Crandall

PINESAP IN WOODS IN THE ENVIRONS OF WASHINGTON

prairies, the common shootingstar flourishes from Pennsylvania to Manitoba and Texas. It flowers in April and May, its five stamens being united in a cone and its one pistil protruding beyond the cone.

Its name comes from *dodeka* (twelve) and *theos* (god). Linnæus imagined he saw in the flowers of its umbel a little congress of divinities seated around a miniature Olympus.

Each flower is so designed that the bee, clinging to it while sucking nectar, receives on its belly the pollen jarred out of the ends of the cone.

Indian-chief, roosterhead, Johnny-jump, and pride-of-Ohio are some of the vernacular names of the shootingstar. The family to which it belongs is a diverse one, including the birds-eye primrose, the featherfoil, the pimpernels, and the loosestrifes.

BLACK SWALLOW-WORT

Cynanchum nigrum (L.) Pers. Milkweed Family [Plate VIII, right]

The black swallow-wort is a garden plant introduced from Europe which has made its escape from formal society and established itself in various sections of North America as remote from one another as Massachusetts, British Columbia, Pennsylvania, and Ohio. It prefers waste places and blooms from June to September.

The family to which the black swallow-wort belongs is cosmopolitan. It consists of more than 200 genera and over 2,000 species. Most of its members have milky juices and many of them climbing habits. They differ both as to their characteristics and uses. Some are delightfully fragrant, while others are utterly evil-smelling. Some species yield fine fibers and others have medicinal properties. Some are highly ornamental. Among the familiar cousins of the black swallow-wort are the butterfly-weed, the swamp milkweed, and the angle-pod.

The winged seeds of the various members of the family make them rivals of the thistles as colonizers. They were employers of lighter-than-air conveyances ages before Montgolfier dreamed of the balloon.

COMMON MOONSEED

Menispermum canadense L. Moonseed Family [Plate IX, left]

Blooming in June and July and maturing its fruit in September, the common moonseed is a climbing vine that ranges from western Quebec and Manitoba to Georgia and Arkansas. It bears bunches of bluish-black berries which resemble small grapes. Most flowering plants have blossoms with pistils and stamens in the same flower. But the common moonseed has flowers that are pistillate and others that are staminate, and bears them on different plants, so that with representatives of this species there are not only distinctly male and female flowers, but even male and female plants.

The common moonseed is a rank grower and

Photograph by Sumner W. Matteson

FLOWERS BY THE ROADSIDE, WITH SUGAR LOAF ROCK IN THE BACKGROUND, MACKINAC ISLAND, MICHIGAN

Although the flowers are prodigal in their offerings of brilliancy, fragrance, and sweetness, when they need the insects they never throw open the doors until the banquet is ready to begin. They offer their gifts only when they are ready to profit by the insects' coming (see page 589).

U. S. National Park Service Photograph

PICKING FLOWERS ON TOP OF THE TRIPLE DIVIDE, GLACIER NATIONAL PARK

The individual plant is the counterpart of a teeming city—its millions of cells, the houses; their microscopic inhabitants, the populace. Sugar refineries, starch factories, milkshops, perfumers' laboratories, and dyestuff establishments are all in operation (see pages 597, 599, and 601).

U. S. Forest Service Photograph

RHODODENDRONS FORM A SETTING FOR A SMALL CASCADE: PISGAH NATIONAL FOREST, NORTH CAROLINA

The triggerlike device in the stamens of the mountain-laurel, by which they are held until a bumblebee releases them and gets dusted with pollen in so doing, is but one of a thousand devices used by plants to make the insects serve them.

Photograph by Ernest L. Crandall

EVEN A DECAYING TREE GIVES LODGMENT TO PLANTS: PLUMMERS ISLAND, MARYLAND

Wild blue phlox (center) and wood chickweed find "good ground" in a rotten place in a tree.

climbs over thickets along the stream banks which constitute its habitat, often strangling other vegetation by its persistent effort to monopolize the sunlight in its vicinity.

PURPLE CONEFLOWER

Echinacea purpurea (L.) Moench. Aster Family [Plate IX, middle]

Whether the purple coneflower belongs to the aster, the thistle, or the composite family depends on what authority is consulted. Some botanists make a very large family and group the sunflower, the thistles, the asters, and the goldenrods together. Gray follows that practice. Britton and Brown subdivide the family and put the purple coneflowers with the thistles. Still others further subdivide the group and cast the coneflower's lot with the asters.

The purple coneflower, growing from 2 to 5 feet high, flourishes in moist, rich soil from Pennsylvania and Michigan to Georgia, Arkansas, and Louisiana. Its flowering season is from July to October. In some sections it is known as the red sunflower and elsewhere as the black sampson.

CANADA WILDGINGER

Asarum canadense L. Birthwort Family [Plate IX, right]

Variously known as the Canada snakeroot, false coltsfoot, colicroot, etc., the Canada wildginger has a range that extends from New Brunswick and Manitoba to North Carolina and Kansas. Its flowering season is April and May, and its flower is a dull, solitary, purplish brown blossom on the outside and creamy white within, which seldom raises its head above the ground, and usually hides among the dead leaves that carpet the floor of the forest.

The lowly position the flower assumes is not a matter of madness without method. Bees and butterflies sleep too late in the spring to serve it in its early adventures. But the fungus gnats and the flesh flies are early on the job, and as soon as they begin to come out of their pupal cases under dead leaves and beneath the bark of decaying trees, the wildginger's flower is close at hand, down in the débris, where there is at once a pleasing haven from cold winds and an abundant supply of pollen for food.

BRANCHING BUR-REED

Sparganium androcladum (Engelm.) Morong. Bur-reed Family [Plate X, left]

Swamps and shallow waters are the branching bur-reed's haunts, and its range reaches from Newfoundland to Minnesota and southward to Florida and Louisiana. The flowering season is from June to August.

The family, as a whole, has flowers arranged like those of the cattail family, but collected in separate spherical heads. They are

Photograph by Harry F. Blanchard

SMILES OF YOUTH AND FLOWERS OF SUMMER

largely self-fertilizing, but aquatic insects and flies render them some assistance in their task of setting seed.

There are 21 principal species of the bur-reed family found in America besides the one illustrated.

GOLDMOSS

Sedum acre L. Orpine Family [Plate X, middle]

Goldmoss is one of those flowers that, growing weary of the coddling of the flower garden, has listened to the call of the wild and gone out to find its own place in the sun. It still prefers, however, to gladden the haunts of men and is usually found along roadsides and on rocks. It came to America as a desirable alien from Europe, and has spread its colonies from Nova Scotia to Ontario and as far south as Virginia. It has many aliases, such as bird's-bread, creeping Charlie, gold-chain, tangle-tail, poor-man's pepper, treasurer-of-love, and love-entangled, which give some idea of how it has entwined itself into the folklore of the country. An old English name was "Welcome-home-husband-though-ever-so-drunk."

The goldmoss belongs to a family which embraces some 600 species, divided into 30 genera. They are of cosmopolitan distribution, though more strongly developed in South Africa than elsewhere. Australia and South America have only a few species representing the family.

In keeping with its life in dry situations, the bulk of the tissue is succulent, forming a water-store that is protected from evaporation by a thick skin.

LIZARDTAIL

Saururus cernuus L. Lizardtail Family [Plate X, right]

The lizardtail is an attractive flower. It possesses a fragrant odor and is found in shallow water and marshes from southern New England to Florida and westward to southern Ontario and Texas. It flowers from June to August, and has a slender stem. It is known also as the swamplily and the breast-weed.

Growing where bumblebees and butterflies are less numerous and where flies abound in great numbers, the lizardtail suppresses the showy petal and substitutes the fragrant odor as its main advertising feature, since the flies are guided by odor, whereas the bumblebees and butterflies are attracted more by color. Hence it is that the lizardtail's flowers are minute and massed, so that the buzzing flies may the more readily communicate the pollen from one to another.

The lizardtail family is notable for its exclusiveness, there being in all North America and Asia only four species belonging to it.

LOW POPPY-MALLOW

Callirhoe involucrata (T. & G.) A. Gray. Mallow Family [Plate XI, left]

The subject of this sketch is a midwestern flower whose range extends from Minnesota southward into northern Mexico. Its flowering season is from April to August. Growing

U. S. Reclamation Service Photograph

GATHERING WILD FLOWERS IN ARIZONA

Flowers that depend on the wind and water to act as their messengers are not beautiful like these. Insects may be lured by attractive odors, bright colors, and sweet nectar, but the wind and water give no heed to such allurements. To provide these qualities would be, indeed, "wasting sweetness on the desert air."

in dry ground, it attains a height of 1 to 2 feet.

The mallow family is a large one, including some 900 species. Among these are the cottonweeds, the hollyhocks, rosemallows, etc.

Many of the mallows are immigrants from Europe and Asia and, be it said, not one of them has proved to be an undesirable alien. Among those that have come to America are: the marshmallow, the mucilaginous product of whose root is the original marshmallow of commerce; the cheeses, which get their name from the shape of their seed receptacles; the velvetleaf, which comes from India; the high mallow, and the musk mallow.

There is one species of mallow whose existence in the United States is a matter of mystery. It is known as *Phymosia remota* and is found only on a gravelly island in the Kankakee River. Whether it is the sole survivor of a species brought out of its original geographic situation by glaciers coming down out of the North in remote ages, or whether it reached there by some other mysterious means, is not known. But whatever its origin, *P. remota* still persists and holds its little domain after all its comrades have apparently been blotted from the earth.

SWEET GALE

Myrica gale L. Bayberry Family [Plate XI, middle]

The sweet gale is another plant whose family name depends on what authority one consults.

Not many species have as wide a distribution, and very few a wider one than *Myrica*

Photograph by Ernest L. Crandall

TWINLEAF AND HEPATICA IN CLEFT OF ROCK: BLACK POND, VIRGINIA

The hepatica is one of the leaders of the floral procession as it comes at the approach of spring, putting out its blossoms even before the leaves venture forth. The twinleaf is often found associated with it in the deep woods, where they together soften the surface of many a cliff.

gale. It is found in swamps and around ponds and lakes from Newfoundland to Alaska and southward to Virginia and Washington. It also spreads across Asia and Europe. Baybush, meadow fern, sweet willow, golden osier, and bog myrtle are some of its American aliases. It comes into blossom in April and May, and it grows from 1 to 4½ feet in height.

The family consists of some 35 species of wide geographic distribution. Its closest relatives are the shrubs variously known as the bayberries, waxmyrtles, or candleberries. From still another cousin is derived the aromatic liquid known as bay rum.

The sweet gale is a small shrub, with leaves somewhat like those of the willow. It possesses a fragrant odor and a bitter taste and yields an essential oil by distillation. It was formerly used instead of hops in the making of beer in northern Europe. When the catkins are boiled in water they yield a scum resembling beeswax, which has been used in the making of candles. The dried leaves are also used to give a scent to linens.

The word gale in use for this plant, among various north-European races, also appears in the forms gaul, gagel, and gagl.

CHECKERBLOOM

Sidalcea malvaeflora (Moc. & Sesse) A. Gray. Mallow Family [Plate XI, right]

The checkerbloom, which belongs to the mallow family, is a resident of the Pacific slope. California school children sometimes know it as the wild hollyhock. Its habitat is open fields in the valleys and on the plains; sometimes it climbs the hills, but loses size when it essays to live too high. The flowering season is from late April to early June, and the stems grow from 8 inches to 2 feet in length.

AMERICAN BURNET

Sanguisorba canadensis L. Rose Family [Plate XII, left]

The American burnet, which flourishes in low meadows from Newfoundland to Michigan and southward to Georgia, growing from 1 to 6 feet high, blossoms from July to Jack Frost time. It is a member of the cosmopolitan rose family and its cousins are indeed legion, as the family embraces some 1,200

© Albert Schlechten

FLOWERS THAT ARRIVE BEFORE THE SNOWS DEPART: SPANISH PEAKS, MONTANA

Would you go sight-seeing through a daisy? Then, in fancy, reduce yourself to the size of a molecule of water and take a trip with the author through one. It contains more houses than New York, more workers than London, more factories than Chicago (see text, page 599).

species, divided into 75 genera. Among these cousins might be mentioned the ninebarks, the meadowsweets, the hardhacks, the goatsbeards, the cinquefoils, the strawberries, the agrimonies, the avens, the raspberries, the blackberries, the roses, and, according to Gray, the apples, the plums, and the cherries.

The Latin name of the burnet genus *Sanguisorba* comes from *sanguis* (blood) and *sorbere* (to absorb), and refers to styptic properties employed in the checking of bleeding in folk medicine.

TRUMPET HONEYSUCKLE

Lonicera sempervirens L. Honeysuckle Family [Plate XII, middle]

Occurring both in low grounds and on hillsides over a range that reaches from Canada to the Gulf and from the Atlantic Ocean to the Rocky Mountains, the trumpet honeysuckle flowers from April to September. It is a scentless but beautiful species, much cultivated, twining about every possible support and climbing high. Its most frequent and welcome visitor is the humming bird, though the long-tongued bumblebees and butterflies are well-received guests at its board.

The honeysuckle family is a far-flung one, with some 300 species scattered all over the world. It includes the elders, the viburnums, the horsegentians, the snowberries, and the honeysuckles.

The honeysuckle puts its nectar down deep so that only those who can serve it profitably as pollen carriers may be able to extract the sweets. But the bees—early risers—are astir long before the friends of the honeysuckle have finished their morning nap, and, biting little holes through the tender tissue at the base of the honeysuckle's tube, they drink the stolen sweets with gusto. Then, when the butterfly and the humming bird come to the feast, they find the cupboard bare. The bees have learned the arts of roguery faster than the flower has built up the strength of its defense.

WITHE-ROD

Viburnum cassinoides L. Honeysuckle Family [Plate XII, right]

This fine shrub blossoms in the early summer and its fruit, first pink and then turning dark-blue or blackish, appears in August. It occurs in swamps and wet soil and has a range that extends from Newfoundland to Georgia and from Manitoba to Alabama. The fruit possesses a bloom like that of the huckleberry. Its tough pliable branches make substitutes for wire and twine in tying rural bundles. Poor mountaineers have frequently used the leaves of the withe-rod as a substitute for tea, hence it is sometimes called Appalachian tea.

Close relatives of the withe-rod are the hobblebush, the arrowwood, and the blackhaw. The viburnums cater to such insects as bees and flies, with short honey-probes. They mass their flowers in dense heads, and the flower tubes are very short.

ROSE POGONIA

Pogonia ophioglossoides (L.) Ker. Orchis Family [Plate XIII, left]

This attractive member of a charming family, which grows from 8 to 15 inches high, is found in bogs and wild meadows from Newfoundland to Florida and westward to Minnesota and Texas, and also in Japan. It blossoms in June and July, has fibrous roots, and propagates itself by runners as well as by seeds.

A shy, timid plant, the rose pogonia is no more like the intrusive blue sailor in its choice of haunts than the hermit thrush is like the saucy English sparrow. But its aloofness in the selection of its habitat is not greater than the ardor with which it invites insect guests to its board. The beauty of its dainty pink flowers is no more appealing to the eye of the bee than their fresh raspberry odor to its sense of smell. Doubly invited, the bee readily responds, and finds a splendid landing platform, all fringed and crested in its honor. Pushing first its head and then its body in between the platform and the column overhead, in order to feast upon the cup of nectar beyond, the bee brings its back into contact with the sticky stigma to which any pollen grains brought from another flower adhere.

SMALL YELLOW LADYSLIPPER

Cypripedium parviflorum Salisb. Orchis Family [Plate XIII, middle]

Found in woods and thickets over a range that reaches from Nova Scotia and Ontario to Alabama and Nebraska, this romantic little member of the orchis family flowers from May to July. Some of the romance woven around it may be sensed by recalling some of its vernacular names, such as whippoorwill's shoe, Indian shoe, ducks, and Noah's-ark.

It is practically a miniature edition of the large yellow ladyslipper and has, generally speaking, the same range. But it adds fragrance to its list of attractions.

The orchis family is represented in every part of the tropic and temperate world. Its members have been described as the gypsies of the flower kingdom. There are few families that can vie with this one in diversity, coquetry, and charm. There are some 5,000 species described to date. Not even the grasses can boast of as many known species. Flower lovers esteem the orchids such beautiful creations and are willing to pay such high prices for rare specimens that they have become the most sought-after family now known to botany. Hundreds of hybrid cypripediums are in cultivation. Some of them are of marvelous beauty. The list of cypripediums in Standardized Plant Names, published in December, 1923, covers more than twelve pages. Once the tulips were as popular as the orchids are to-day, and the craze for them came to be known as "tulipomania."

About the only members of the orchis family that have an economic status are the two species that produce vanilla.

U. S. Forest Service Photograph

REBUKING THE DESPOILER

The forest ranger is here handing the flower vandal an opinion of his act "straight from the shoulder." Unless public sentiment backs him up, our woodlands adjacent to cities will soon be stripped of their springtime beauty.

ARETHUSA

Arethusa bulbosa L. Orchis Family [Plate XIII, right]

The three orchids shown on Plate XIII represent three different genera of the orchis family, with characteristics widely different. Arethusa, known also as Indian pink and dragon's mouth, has a range that extends from the Canadian North to South Carolina and Indiana. It is found in bogs and swamps, growing from 5 to 10 inches high, and blossoming in May and June. Its flowers have a violetlike scent.

Linnæus fancied this flower a maiden in the midst of a spring whence she had gone to find a place where none could follow her. Recalling the legend of Arethusa, the nymph, changed by Diana into a fountain in order to protect her from the infatuation of the river god, Alpheus, who had become desperately in love with her on seeing her at her bath, Linnæus gave the flower the name of the nymph.

This name fits the flower even better than the great botanist dreamed. It has been pursued persistently by the lucre-loving orchid hunters who gather it for European collectors and who are more vigorous and unrelenting in their attentions toward the nymph than was the god.

Catering to the bees and bumblebees in much the same fashion as the small yellow lady-slipper, Arethusa has only one flower to a plant and that often fails to mature seed. Limited in its power of reproduction and pursued by a thousand human foes, it has become rare where once it was plentiful, and it now abounds mainly in places and surroundings that protect it from its enemies.

TAWNY DAYLILY

Hemerocallis fulva L. Lily Family [Plate XIV, left]

The tawny daylily is a native of Europe and Asia which crossed the seas at the bidding of flower-loving Americans, and became popular in the gardens of the East. But generations of coddling at the hands of horticulturists have not served entirely to breed out of it a desire and an ability to shift for itself, so we see it labeled an "escape" in the botanist's manuals. It has gained a foothold from New Brunswick to Virginia and Tennessee, where it flourishes in meadows and along streams, blossoming from June through August, and attaining a stem growth of 3 to 6 feet. It is known in some localities as Eve's-thread, and in others as the lemonlily. It gets its botanical name from the Greek, which proclaims that it is

beautiful only for a day. Less attractive as a plant than its more pretentious sister *H. flava*, and odorless, it makes up in the beauty of its tawny flower what it lacks in plant symmetry and fragrance.

The lily family is a large and cosmopolitan one, embracing some 1,300 species distributed over all sections of the globe. The versatility of the family is great. The leek, the garlic, the onion, the tulip, the troutlily, and the hyacinth, all belong to the family. Some authorities expand the family to include the trilliums, the asparagus, the asphodels, and other interesting plants.

FIELD GARLIC

Allium vineale L. Lily Family [Plate XIV, middle]

Of all the undesirable aliens of the plant world that have obtained a foothold on American shores, none takes higher rank in undesirability than the field garlic. It came as a stowaway and has spread rapidly over the eastern part of the United States. It justifies the farmer's assertion that it "seeds at both ends," since it not only bears a whole umbel of seeds and bulblets on its onionlike stem, but a lot of tiny onions at the root. As it gives a garlic flavor to milk and butter it is particularly objectionable in pastures.

From the earliest times garlic (*Allium sativum*), has been a relish with a great many people and anathema to many others. It was eaten by the children of Israel during their stay in Egypt, and furnished to the laborers by Cheops while they were building the great pyramid that bears his name.

GRAYS LILY

Lilium grayi S. Wats. Lily Family [Plate XIV, right]

Grays lily, a typical mountain flower, belongs to the southern Appalachians. It is a scentless member of the family and is closely related to the Canada lily.

Its flowers are somewhat smaller, its color tone is deeper, and its head more often nods. When cultivated it loses its differentiating characteristics and sooner or later shows more of the character of the Canada lily.

POISON SUMAC

Toxicodendron vernix (L.) Kuntze. Sumac Family [Plate XV, left]

All authorities agree that, not even excepting the poison-ivy, this species is the most poisonous of the sumac or cashew clan. It is found in swamps from Maine and southern Ontario southward to the Gulf of Mexico and as far west as Minnesota and Missouri. It blossoms in June and bears its fruit in the late summer. The wood of the poison sumac weighs 27 pounds to the cubic foot and is of a soft texture, yellowish-brown in color.

There are some 500 species of the sumac family, most of them keeping within the warm and tropical regions. Only a few species have had the courage to brave the cold and secure a footing in our latitudes. The leaves and bark of the smooth sumac are gathered and used in tanning in the South. The bark of staghorn sumac is also rich in tannin. The fragrant sumac has a range embracing the region east of the Mississippi and is as sweet-scented as its cousin is poisonous.

CALIFORNIA RHODODENDRON

Rhododendron californicum Hooker. Heath Family [Plate XV, right]

Known also as the California rose bay, the California rhododendron is one of the Pacific coast's most charming flowers. It is the species adopted by the State of Washington as its official flower. A splendid shrub, by many regarded as the handsomest indigenous to the Pacific States, it grows from 3 to 15 feet high and has a grayish trunk. The leaves are from 3 to 10 inches long and are leathery and smooth, but not shiny. The flowers are scentless and the stamens terminate in anthers that resemble tiny serpents' heads.

With richly colored flowers mixed with crimson-tipped buds, and backed by dense green foliage, the shrub gives a striking combination of delicate and brilliant tints, which, met with in such places as the redwood forests, stir the soul of the beholder. California rhododendron belongs to the heath family, of which about 1,100 species have been described.

CREEPING POLEMONIUM

Polemonium reptans L. Phlox Family [Plate XVI, left]

The creeping polemonium is a dainty flower that flourishes in open woods from New York to Georgia and westward to Minnesota and Kansas.

Some of the garden varieties of phloxes have been bred from *Phlox drummondii*, a Texas species. The tall sweet-scented garden phloxes were bred from *Phlox paniculata* and *P. maculata*. Europe, appreciating our wild flowers more than we do, carried representatives of these species across the Atlantic and developed therefrom many beautiful varieties that came back to America to thrill millions of flower lovers.

SWEET-WILLIAM PHLOX

Phlox maculata L. Phlox Family [Plate XVI, middle]

This pleasing member of the phlox family lives along streams and in moist woods east of the Mississippi River and south of Massachusetts. Its flowering season extends from mid-June to late August and it has a stem growth of 1½ to 3 feet. It frequently escapes from cultivation farther north and wanders along dry and dusty roadsides. Hawthorne's little red cottage at Lenox, Massachusetts, lies in ruins, but the white phlox his wife planted

Photograph by T. E. Marr

A LILAC BORDERED DRIVE OF THE ARNOLD ARBORETUM, HARVARD UNIVERSITY

there has not only survived but has spread over the hillside.

In order to defend their sweets against pilferers who could render them no service as pollen carriers, many of the phloxes have coated their upper stems and the base of their flowers with a sticky substance that forms an effective barrier to an approach. Thus the phlox does for itself what men do for the trees in keeping the caterpillars from reaching the branches.

ALFALFA

Medicago sativa L. Pea Family [Plate XVI, right]

While alfalfa is generally known as a forage plant, it has shown some ability to leave the farmer's fields and strike out for itself. It is therefore sometimes encountered as a wild flower between Maine and Virginia, and westward to the Pacific coast, growing from 1 to 1½ feet high and flowering from June to August. Several crops may be harvested on the farms in the course of the summer.

It is a leguminous plant which gathers nitrogen from the air, uses what it needs, and sends the "crumbs," as it were, into the soil. The locust tree belongs to the same family of plants. As these legumes reverse the process of those plants which extract nitrogen from the soil, they are known to the farmer as great promoters of soil fertility. In England, alfalfa is known as lucerne. The name "alfalfa" is of Arabic origin, and means the "best fodder," a verdict rendered by the Arabians and affirmed by American experience.

Alfalfa was introduced into Italy from the eastern Mediterranean countries in the first century, A. D. The Spaniards gave it further vogue in Europe, and finally, about 1650, it was introduced into England. Sometime before that it was brought to Mexico, later to California, and in the middle of the nineteenth century it began to command the favor of American farmers, generally.

Some botanists call the family to which the alfalfa belongs the pea family; others call it the pulse family.

NORWAY AND THE NORWEGIANS

By Maurice Francis Egan, Litt. D.

Late United States Minister to Denmark

Author of "Denmark and the Danes," in the National Geographic Magazine

NORWAY is one of the new nations, although it possesses one of the oldest histories in the world; it did not become independent until the year 1905, through a carefully negotiated separation from Sweden.

It is needless to say that the Swedes were not pleased—they are perhaps, except the Spaniards, the proudest people in the world—and when Norway presumed to cast off the mild rule of King Oscar and become "Norway for the Norwegians," war between Sweden and Norway seemed very near.

The Swedes were ready to mobilize. The officers of the army abroad were called home, but through the good sense of both, assisted by the Norwegian Minister of State, Christian Michelsen, this danger, which would have been a great misfortune for both countries, was averted.

Of the three Scandinavian countries, Norway is the least in population, the Norwegians numbering not quite two million five hundred thousand. In comparison, the population of Sweden is more than double this, and that of Denmark somewhat above it.

NEW NATION BECOMES A MONARCHY

In dealing with the Norwegians one can not help using superlatives, and one need not excuse one's self for saying that they are the most democratic people in the world—that is, the Western world.

If their common sense had not played such a great part in their negotiations for separation from Sweden, they would have become a republic. It was no doubt the influence of the great powers that induced them to retain that monarchical form of government which had been historic with them.

The Norwegians are very modern in their point of view; they have put in force the methods of a conservative socialism, and they do not hesitate to adopt any progressive idea which seems to fit in with their civilization.

Foreigners sometimes call them obstinate, but they look on themselves as merely firm. They are fixed in their opinions, but they do not attempt to force their opinions on other people.

And, whether it is the influence of their great coastline, of their splendid fjords, or of their love of the sea—there is a strange reflection of the color of the sea in the eyes of the Norwegians—they are open-minded and far from insular.

THE NORWEGIANS CHOOSE A DEMOCRATIC KING

In choosing a king they were largely guided by their own principles. Having a state church, the Lutheran, by law established—though most of them regard a state church as an anomaly—they must choose a Lutheran king and one with extreme democratic tendencies, and they wanted a queen, too, who would sympathize with their democratic ideas. No German prince need apply.

They chose Prince Karl of Denmark, brother of the present king of that country, and he assumed the title of Haakon VII. His wife, Queen Maud, daughter of King Edward VII of England, was already known to them. She had lived in Copenhagen and been justly respected and admired. It was impossible that a granddaughter of Queen Victoria should not have a proper sense of her own dignity; but this dignity was rather personal than royal.

To see Queen Maud at a court function in the Palace of Christiania, dressed simply and appropriately in her favorite white, is to have a vision of graciousness and to understand why the Norwegians love her, not only because she is the mother of the prospective heir to the throne, Prince Olav, but for herself as well.

Prince Olav has gone to school just like any other well-brought-up Norwegian boy. He is willing to be a prince, because it is expected of him, but he puts on no airs, and he seems—his comrades

Photograph by A. B. Wilse

ARRAYING THE BRIDE IN HER WEDDING FINERY: NORWAY

In remote sections of the country one may still see a real Norwegian wedding. The bride, wearing the native dress of her particular district, rides to the church on a pony which is led by the master of ceremonies. If the pony is strong enough, two or three of her relatives also ride. After the ceremony, there is a dance upon the green, a wedding supper, and general merrymaking, which lasts until late at night, only to be continued for the next two or three days.

Photograph by Donald McLeish

FOUR FRIENDS OF THE HALLING VALLEY

say—not to count too much on being King of Norway, although, in spite of their republicanism, the Norwegians look on him as the pledge of a future stable government.

There is no patriotic Norwegian who does not regard his winter sports as the necessities of life; and Prince Olav has been brought up to be a good Norwegian sportsman, in a country where it is rather unpleasant to be too rich and where open-air sports, the cultivation of the mind, and acute interest in literary and scientific pursuits mean much more than the piling up of money.

It is unpleasant to be rich, because the government, in its energetic economic capacity, makes the life of a rich man a burden, by tremendous taxation. Sometimes in Norway one can begin to understand the meaning of the Oriental legend in which the only happy man appears to be the one who possesses nothing but a shirt.

A HANDSOME SAILOR KING

The King and Queen live alternately, without ostentation of any kind, in their palace in Christiania and in their country house on the peninsula of Bygdö, a short distance from Christiania. The only luxurious thing about them is a splendid white bearskin used as a sleigh robe when they drive through the streets of Christiania.

King Haakon is a remarkably handsome man. He had been a sailor in his youth, brought up with a stern sense of

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BRIGHT FACES LOOKING OUT FROM AN OLD VIKING BALCONY

The Viking ancestors of these pretty Norwegian lassies, with great daring, pushed their high-prowed boats across the unknown Atlantic to Iceland in 861, to Greenland in 982, and to the North American coast in the vicinity of Newfoundland and Labrador, and probably as far south as the New England coast, between the years 985 and 1011.

duty, a knowledge of economics, and a great sympathy with the progress of peoples. He speaks well, briefly to the point, and he possesses a melodious voice; but probably no other man, not even another sailor, hates to speak in public more than he does.

I remember on one occasion sitting near him at dinner. "The King eats little," I could not help remarking to the lady in waiting next to me, "and yet he does not look ill."

"The King," she answered with a smile, "is neglecting his favorite dish, which is roast chicken, because he is expected to make a speech, and that is the one horror which can make a good Scandinavian like him neglect his food!"

"A CONSTITUTIONAL PRESIDENT FOR LIFE"

Speaking of democracy, work is not looked on as menial in Norway. I recall the incident of an American woman, visiting Christiania, who, having been invited to a court ball, went to a hairdresser's. The *coiffeuse* was very amiable, well bred, and efficient. Nevertheless, the guest was astonished when she saw in the ballroom this *coiffeuse* leaning on the arm of her husband, a lieutenant in the army. This was not regarded as in any way remarkable in democratic society.

"I am afraid," the King of Norway once said to me, "that you Americans look on us as almost too democratic; in fact," he added, smiling, "your President is a king for four years, while I am a very constitutional president for life."

Now, many persons in our country who are not at all conservative may be rather amazed by the incident of the hairdresser appearing at the ball and by her taking the proper rank; but it must be remembered that occupation, in Norway, does not imply ill breeding, coarseness, or a lack of knowledge of the finer things of life. It is very probable that this woman, who helped to eke out the small salary of her husband, without loss of dignity, spent a month each winter on the Riviera or in Italy or in Paris. She and her husband probably lived in what would be considered rather cheap lodgings—in what the French call *hôtels des nobles ruinés*—but that would not prevent them from enjoying the best things which Italy or France has to offer.

Norway is one of the few countries in which luxury is not regarded as a necessity of civilized life. I recall, with amusement, the astonishment excited in university circles when an American professor appeared with a splendidly dressed wife, a Rolls-Royce car, a valet, and a maid. By reason of his splendid appurtenances, his reputation as a scholar was almost ruined, in the eyes of the Norwegians and the Danes, who associated high thought with simple living.

I remember the impression made on my mind by one of the gentlemen connected with the University of Christiania, when I stopped at the hotel to leave a card for this eminent American scholar just after he had arrived. The Norwegian teacher, who had seen him drive up in his limousine, asked me who he was. I told him. "It's impossible; he can't be a professor!" was the comment.

The impression has gone abroad that because Norwegians are frugal their country is impecunious. This is not true. A small country which can afford to devote each year to the church, to the schools, to the encouragement of science and art about two million dollars can not be said to be either miserly, mercenary, or very poor.

NORWAY'S LANGUAGE TANGLE

There is one thing which the Norwegians have not yet learned, although Björnstjerne Björnson, with all his authority, tried to teach it to them—that the multiplication of languages is a bad thing in any country, since it adds to the difficulties of the working as well as the business man.

The literary Norwegian language, as written and spoken, resembles Danish very closely, although the inflections and intonations in speaking are different. Well-spoken Norwegian is almost a harmonious chant; but, no matter how well the Norwegian may speak his own language, it takes him a long time to learn English well, and a longer time if he must disentangle himself from the composite language called *maal,* which certain patriots are doing their best to make general in Norway.

The *maal* is not really a dialect of the peasants; it enshrines no folklore. It is, as a learned professor says, a kind of

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A BIRNAM WOOD OF A THOUSAND SKIS

This crowd is waiting at a Christiania railway station to board the train for Finse, the highest point on the Christiania-Bergen Railroad. The annual ski meet at Holmenkollen is one of the principal events of the sporting world in Norway, and is watched by thousands of spectators. The origin of the sport is unknown, but records going back 600 years before the Christian era speak of people who run on the ski.

Photograph by A. B. Wilse

THE RECESS HOUR AT A NORWEGIAN BOYS' SCHOOL

Norway has for years been considered an ideal summer playground for tourists, but it also is unrivaled as a resort for winter-sports enthusiasts. The long, gentle mountain slopes are especially suitable for skiing and tobogganing. There is little fog or chill, the air being crisp, dry, and exhilarating.

© A. B. Wilse

THE SNOWY PEAK OF THE GLITTERTIND

The Jotunheim, a mountainous region of southern Norway, has an area of 950 square miles and contains some of the highest mountains in the Scandinavian Peninsula. The Glittertind, 8,380 feet, is the second highest in this region. The term Jotunheim (Giants' Home) is a reminder of the mountain-dwelling giants of Norse fables.

Esperanto, founded on the ancient dialects, a mosaic carefully put together by skilled philologists and ardent patriots of the Liberal Party.

A one-time premier of Norway was most enthusiastic in his desire to have this speech the common language of Norway. He seemed to forget that it is not languages, but ideals in common that bind men together.

It would be unreasonable for many Americans to disregard English because it is not the inherited tongue of a great number of them, but only an acquired language, in order to go back to the Choctaw, the Iroquois, or to a mixture of the Spanish of New Mexico, the French Canadian, or patois of rural New England, to the German of Wisconsin, and the Celtic of the Irish in America who know their ancient language, or to the Gaelic of the emigrant Scotch Highlander.

Before the war a man who dared to oppose the compulsory introduction of the *landsmaal* would have acquired a host of enemies—the fight for this national language was so ardent. But Björnstjerne Björnson's struggle for the literary language in use had its effect, and now the results of the war have turned the attention of the Norwegians to the tremendous advantages of their country industrially, and, as they become more and more devoted to utility, the desire for an archaic language may disappear.

But this is a matter for the Norwegians themselves to decide; a foreigner has scarcely a right to an opinion on this subject, though he may be excused on the ground that, in order to master Norwegian literature in the future, he may hope not to be expected to learn two languages.

TWO LITERARY GIANTS OF NORWAY

The critics and the sociologists have several opinions as to the value of the works of those two great Norwegians, Björnstjerne Björnson and Henrik Ibsen, from the literary and ethical points of view. There is no question, however, that Ibsen revolutionized the drama, as to its form, in all civilized countries.

But it is amazing that this country of Norway, the home of robust fishers and seafaring men, who had been brought up to reduce material life to its simplest elements, has produced a group of writers and musicians whose fame is international and must be enduring. One can not mention modern music without thinking of Edward Grieg, of Ole Bull, and of Christian Sinding.

The novel with the thesis flourishes in Norway. The question of sex and the sex relations and their effect on society in general is not so much of an obsession as it is with the newer school of English novelists.

The matter of women's rights is settled in Norway. A woman now, if she can secure the requisite number of votes, is eligible for any office except in the church and in the diplomatic service.

The struggle for women's rights assumed form in Norway when Jacobine Camilla Collett, sister of the romantic poet, Henrik William Wergeland, wrote her novel, "The Governor's Daughters."

Society in Norway, as in nearly every other country, complacently admitted that a different standard of sexual morality existed for women and men. In 1883 Björnson's play, "A Gauntlet," appeared. The chronicles of that time show that in Christiania and in the smaller centers of Norwegian culture a storm was raised over this drama, which tore all social gatherings into factions and made the rival newspapers thunder. Björnson had insisted solemnly that there was only one standard of chastity.

He was taken most seriously, and *prétendants* for the hands of young women were frankly questioned as to their past, which astonished and irritated them extremely. We are told that societies for the preservation and encouragement of sexual morality among the men were formed, and all prospective husbands were put through the test which Björnson's play had suggested.

Whether a reformation in the male sex was made or not, it would be rather impertinent to ask. "A Gauntlet," however, was gradually forgotten as to its thesis and is now occasionally played as one of the Norwegian semiclassics.

Both Sweden and Norway are greatly interested in the Nobel prize, and Björnson was an early recipient of the literary award, in 1903. Roosevelt was on his

Photograph from International

MEMBERS OF THE NORWEGIAN ROYAL FAMILY ARE WINTER-SPORTS ENTHUSIASTS

Skiing may be called the national sport of Norway, for the royal family delights in it and it forms a part of the training of the Norwegian army. Kongssaeteren (literally, "the king's saeter"—see page 668) is a favorite resort in winter for this sport. In the illustration the King of Norway is on the extreme left and the Queen is third from the left.

way to Christiania to make his speech, in the character of a recipient of the Nobel peace prize, when Björnson died, in 1910.

His obsequies were celebrated, both in Christiania and in Copenhagen, with a solemnity befitting the funeral of a great monarch. I remember with what anxiety we in Copenhagen watched the news of his illness. We were most anxious that this giant of letters, who resembled our poet, Walt Whitman, should live as long as possible; and the secondary reason for this was that the popular mourning at his funeral in Christiania might interfere with the splendid reception of ex-President Roosevelt which the Norwegians had prepared.

Björnson was always courteous socially, but nobody expected that he would show the exquisite politeness of dying just in time to give the Norwegians the opportunity of offering a gala to one of the greatest of modern Americans.

It is remarkable that the Scandinavians, who love France and Italy, while they have always had a certain intellectual respect for Germany, but no affection, should have remained so national in spite of the fact that none of them stayed entirely at home. Thorwaldsen, the Danish sculptor, borrowed greatly from Greece and Rome and his next country of preference was Italy.

WEAVING AND CHINA MANUFACTURE ENCOURAGED

The Norwegians have never lost their love of the arts and crafts of the people. Munthe deserves the credit of having encouraged cordially the art of weaving among the people, and the progress of tapestry making in Norway is marked from year to year. I hope that that institution for the cultivation of the beautiful in textile arts, the Philadelphia School of Design for Women, will some

Photograph by Donald McLeish

ON GUARD BEFORE THE ROYAL PALACE AT CHRISTIANIA

He is a sentry of the First Company of the King's Guards, the oldest of four companies of royal guards.

Photograph by A. B. Wilse

THE ZIGZAG ROAD TO MYRDAL

This station on the Bergen-Christiania Railroad is the highest point of the Flaam Valley, to which many tourists drive in two-wheeled carriages called *stolkjærre*. The road, a marvel of engineering, runs through wild ravines and along towering mountain cliffs, past high waterfalls. The last part of the road ascends in a zigzag of seventeen curves. There is a drop of 1,200 feet from the hotel on the left to the river.

Photograph by A. B. Wilse

A LEFT-OVER CATARACT AND ITS COMPANION POWER PLANT

A few years ago the Rjukanfos, or "Reeking Fall," 345 feet in height, was one of the greatest waterfalls in the world, and in spite of the tax which industry has placed upon it, it still remains one of the most beautiful in Europe. The power-house shown in the photograph turns the wheels of the greatest nitrate plant in Norway (see also illustration, page 684).

day or other import some of the examples of the weaving and designs of Fru Frida Hansen. Her best work is a reproduction of a historical design done by Munthe.

As yet, Norway has not rivaled the famous porcelain of Copenhagen; but Thorolf Holmboe has produced a china of Porsgrund made characteristic by its pictures of little polar bears and its fine glaze.

The Norwegians are quick to encourage new designs in jewelry founded on early national themes. In the country districts one frequently sees very beautiful examples of the jeweler's art done by village craftsmen, and many of the peasant girls would disdain to wear the vulgar ornaments, made by the bushel, eagerly bought up by tourists who have not yet learned that jewelry ought to be as individual and as national as possible.

Norway does not show such a dislike to emigration as Sweden. You can scarcely enter into conversation with an intelligent and patriotic Swede without hearing regret that so many of his countrymen have gone to the United States and other American countries. He does not hesitate to say that he looks especially on the United States as a sponge, which is absorbing the strength of his country, if not its brains.

It has become almost a passion in Sweden to prevent emigration, and even the present King of Sweden, who is very tolerant, has made it known over and over again that he would be very happy if he could keep his people at home.

In Norway, however, although the patriotic citizen desires that the Norwegian should stay in his own country, he is still a Viking at heart, and any great adventure appeals to him. It is true, too, that if the government should attempt through legal disability to keep the honest Norwegian at home, he would probably emigrate in a body.

The horror of the Puritan at the illegitimate child is hardly understood in the rural districts of Norway, and in the cities it does not seem ever to have existed. In contrast to this laxity, there is a great honesty, a great sincerity, at times an almost intolerable frankness, and a love of justice.

TOURISTS SELDOM LEARN HOME LIFE AND CHARACTER OF THE NORWEGIANS

The tourist who knows only the northern coast of Norway, or one who judges the country only from the pictures of the novelists and magazine writers, learns very little of the home life of the people, and, seeking the picturesque and the unusual, overlooks the serious spirit and the economic progress which characterize the inhabitants.

In Europe, if an American does not speak with a provincial accent he is set down as not a real American. Similarly, a Norwegian must be ferocious, in a manly way, robust, and almost brutal, or he is not a real Norwegian. It is not understood that in Norway one does not live constantly under snow and between great fjords, and that there is sometimes even great tranquillity without melancholy among the people.

On one occasion in Copenhagen the best-known composer of Icelandic music—that is, of music founded on Icelandic themes—gave a concert. The Concert Palace was crowded, but nearly everybody came away disappointed. The symphonies were not at all Icelandic, they said. The ancient story of the man who saw a lion in a menagerie for the first time and said, "That ain't no lion," applies here.

Another impression very hard to dissipate is that the Norwegian is a hard drinker. It is supposed that he almost lives on the wine of the country, *braendevin*, a kind of gin, and in the popular stories the Norwegian in a mob is always drunk, if a terrible Swede can not be found to assume that character.

The romancers would lead us to believe that *"Skaal!"* is his favorite salutation, always accompanied by huge draughts of some fiery liquid. The legend that his ancestors drank the most ardent mead from the skulls of their enemies has tinctured the modern attitude of mind toward all the Scandinavians.

The characters of the Dane and the Norwegian reflect the geography of their countries.

Denmark is flat, lake-studded, a series of islands. It is almost entirely agricultural. It has its fisheries of great extent, it is true, but the famous Danish sole is not of the kind that makes its home near a rocky and tumultuous coast. Denmark has no natural, merely industrial, advantages.

Norway, on the contrary, now that its people have begun to understand the value of their "white coal" and are using their schools to produce scientific men, is rapidly becoming one of the most important industrial factors of Europe.

BERGEN WAS ONCE THE FISH MARKET OF CHRISTENDOM

I admit that I am amazed by the industrial development of Norway; but to me the fisher folk and the fishers seem the most interesting of all the Norwegians who work with their hands, and consequently Bergen, with its great fish market, seems to me worthy of the closest study. Much earlier than the thirteenth

Photograph by Donald McLeish

A RURAL DÉBUTANTE OF NORWAY

Her gown is smart and modish, though her grandmother probably wore one exactly like it. She delights in her brooch and buckles of silver, and her bodice of red material, which is adorned, as is her cap, with colored beads in varied designs.

Photograph by Donald McLeish

THE NAERÖ WINDS BETWEEN THE EVERLASTING HILLS

This deep, somber valley, flanked by sheer mountains, with a threading torrent rushing between the few scattered houses, affords one of the most impressive views of inland Norway. On the left is the blunted cone of the Jordalsnut. In the distance are the mountains surrounding the equally wild Naerö Fjord.

Photograph by Donald McLeish

A SHY LITTLE MAID OF THE NAERÖ VALLEY

The high peaks which enclose the deep valley of the Naerö are so steep that the people never see the sun in winter, but this wildest part of Norway attracts thousands of summer tourists. This little girl is wearing red stockings to enliven her black and white costume, and the inevitable large silver brooch which most Norwegian women affect.

Photograph by Donald McLeish

WHERE FARMING IS FRUGAL AND PRIMITIVE

Farms nestle in every fertile spot in the narrow valleys, on diminutive islands in streams, and on rocky shelves on the cliffs of the fjords. In some regions hay is rolled into bundles and let down by wire ropes from a mountain farm to the barn, far below.

Photograph by Donald McLeish

MAKING HAY ON A NORWEGIAN FARM

Contrary to the custom of other countries, where hay is gathered into sheaves or shocks, the Norwegian farmer suspends his fresh mown hay on wire strands strung along rows of upright posts. This hay arbor is advantageous in a damp climate.

Photograph by Donald McLeish

AN ARCHITECTURAL MYSTERY NEAR BERGEN

The origin of Norway's ancient wooden churches, or *Stavckirker,* resembling Chinese pagodas, is unknown. At one end of this church is an opening known as the Lepers' Window, at which a leper communicant, standing outside, could receive the Sacrament.

Photograph by Donald McLeish

A HOUSEWIFE OF AAL MAKING "LEPSE"

This is a sweet bread flavored with aniseed, rolled very thin, and baked on an iron plate over an open fire until crisp. It is much more of a delicacy than the familiar *fladbröd,* which differs from the Swedish bread, *knäckebröd,* made from rye.

Photograph by Donald McLeish

BREAKFAST IN AN ANCIENT FARMHOUSE OF THE HALLINGDAL

Many famous Norwegian sagas, half legend, half folktale or history, are associated with the Halling Valley, where, in the summer, the Norwegian drives his cattle to the *sæter* or out-farm, situated in the mountains some miles from the home-farm.

Photograph by Donald McLeish

A STEAM YACHT ANCHORED AT THE HEAD OF THE NÆRÖ FJORD

This is one of the most impressive fjords in Norway. It is not navigable in the spring, as torrents of melting snow and ice from the mountains, carrying along rocks large enough to sink a passing vessel, dash down its perpendicular walls.

Photograph by Donald McLeish

A CHAT BY THE EDGE OF AURLANDS FJORD

Waterfalls, on both sides, leap out direct or glide in foamy streaks over dark-brown rock down precipices from 3,000 to 3,900 feet high. A few houses have been built on alluvial deposits or perched on lofty rocks. This fjord is rich in fish, much of which is exported, and the inhabitants, when not afloat, spend their time in making and repairing nets.

Photograph by Donald McLeish

A MATRON OF THE HARDANGER DISTRICT

Locality, not changing fashion, gives diversity to Norwegian styles. By their embroidery and design one can tell the district, sometimes the village, of the wearer. The Hardanger costume is regarded as one of the prettiest of all Norway. The distinctive mark of the married women is the *skaut*, a white linen cap folded and starched.

Photograph by Donald McLeish

FASCINATED BY A BOOK OF PICTURES

These little maids of the Hardanger are arrayed in gaily colored bonnets and bodices of red velvet adorned with colored beads worked into intricate designs. The silver *solje*, a kind of brooch, generally an heirloom, is a characteristic feature of the costume.

Photograph by Donald McLeish

GIRLS OF THE HARDANGER DISTRICT AT THE EDGE OF THE BEAUTIFUL VOSSEVAND: UNMARRIED WOMEN DO NOT WEAR CAPS

At the eastern end of this lake, between the Hardanger Fjord and the Sogne Fjord, the famous tourist district of Norway, lies the little town of Voss, whose old stone church dates from 1271.

Photograph by Donald McLeish

GIRLS OF VOSS AT THE DOOR OF THEIR HILLSIDE DWELLING, A TIMBER CHALET MORE THAN 200 YEARS OLD

Far removed from the valley, the people are self-supporting, and the churning of butter and the making of cheese are carried on at their homes. The costume worn is similar to the Hardanger dress, except that the skirt is dark green.

Photograph by Donald McLeish

VILLAGERS OF AAL, IN THE HALLING VALLEY, STANDING ON THE STEPS OF THE 17TH CENTURY COURTHOUSE AND TOWN HALL

On Sundays the women wear the local costume, which in its peculiar cut and gaudiness of coloring is unlike those of any other part of the country. The variety of colored wools used in the embroidery and the numerous silver buckles and brooches produce an almost barbaric effect.

Photograph by Donald McLeish

THE ENTRANCE TO THE ANCIENT HANSEATIC "GAARD," IN BERGEN

Bergen's commercial prosperity in early times was due to the merchants of that giant medieval trust, the Hanseatic League, which established an office here in 1445. The timber *gaards,* or warehouses, provided quarters for the merchants and their assistants. The wooden figure above this entrance represents a workman in the dress of the period. He holds a small ax, used to kill and cut fish, for which Bergen is still an important trading center in Scandinavia.

century a great part of Christendom was supplied through Bergen, on Fridays and other days of abstinence, with dried fish.

Even now cod, dried after the manner of the Middle Ages, is exported in great quantities. The process of salting fish has of late taken the place of the old method of drying. Salted fish is called *klip fisk*.

THE EPICURE DELIGHTS IN BERGEN FISH

As the perennial cod has given its name to a certain class of aristocracy, known in New England as "codfish aristocracy," *klip fisk* is a phrase frequently used in connection with the Scandinavian immigrant in this country, especially in Minnesota; but he is so practical, as a rule, that he does not resent a term which reminds him of one of the industries of his native country, Norway or Sweden.

Bergen's reputation as a fishing port extends over the whole world. Its export of fish probably rivals the almost universal Danish export of butter. A sojourn either in Copenhagen or Bergen spoils the appetite of the confirmed fish-eater for fish in any other country.

In Copenhagen your cod, which when properly boiled and with the right kind of sauce is quite as good and less cloying than the salmon, is brought kicking to your door. "Hans," I once said to the most admirable of major-domos, "that cod you brought in last night to the table was enormous." "You should have seen, sir," he answered, "his struggles in the kitchen; I had a hard time killing him."

And in Bergen you can pick up in the fish market the most delicious fish ever created; and the Norwegians have almost as good a taste in sauces as the Danes, but they are not quite so Parisian. If the Danish sole would make a reputation for any country—when it is perfectly fresh it is even better than the English sole—a fresh cod and even the herrings of Bergen are very close in competition. It is unfortunate that in our country we seem to have all kinds of fishes, but only one sauce.

The sole of Denmark does not exist on the coast of Norway and our flounders are not found there. The cod and the herring are the typical Norwegian fish; the cod yields by-products of which cod-liver oil is the most important. The herring is a capricious fish and it is always rather a gamble as to whether a season will be good or not. The fishermen must remain taut and intensely ready to take advantage of their appearance.

The Lofoten fisheries are the centers of the greatest activities. There was a time when the fishermen traveled in open boats, but now the process of fishing is more scientific. The motor-boat was introduced, and the Norwegian fishermen would, I fancy, give a great bonus to any inventor who would produce an entirely noiseless type of this craft.

The Norwegians are greatly interested in religion and even in theology. The fishermen in their hours of ease divide their discussions between religion and politics.

THE LAND OF THE SKI

Norway is often called the land of the ski. It is not an appropriate title, but unfortunately it has given the impression that the country is merely a land for tourists, who look on it as a place for the enjoyment of this kingly sport. In the winter everybody in Norway, outside the cities, goes on skis, which are not our snowshoes nor are they operated in the same way. Prince Olav owes much of his popularity to his being one of the most birdlike, graceful, and forceful managers of the Norwegian ski, which in skillful hands seems to partake of all the qualities of running or flying birds and animals. The art of skiing is part of the national education, and woe be to him who thinks that he can master it easily.

Some day an epic poet, under the new psychological pressure which interprets the complex, will no doubt make the ski the subject of a poem which shall include the expression of all the Norwegian national characteristics. It is a democratic sport; it does not require the outlay of money necessary for polo or even golf, and he who studies the science and art of the ski will learn many of the secrets of this unique, progressive, yet unchanging people of the North, who, like skilled masters of the ski, always manage to fall on their feet.

Sailing into the harbor of Christiania, one's first impression is that of what is

© A. B. Wilse

ON THE LOFOTEN BANKS

The four large islands of the Lofoten group, with many smaller ones lying between, have been aptly likened to a gigantic backbone trailing off from the Vesteraalen Islands into the Norwegian Sea. During the fishing season fishermen from all of northern Norway distribute themselves over its 36 banks. The dread Maelstrom, which figures in one of Edgar Allan Poe's weird stories and in Jules Verne's "Twenty Thousand Leagues Under the Sea," is off the southern tip of this archipelago.

Photograph from Dr. Hugh M. Smith

A FISHING FJORD IN THE LOFOTEN ISLANDS

Many hundreds of boats crowd into a small area. The larger sailing vessels buy the fish and transport them to markets in the larger cities, and the smaller boats offer their catches for sale. Most of the fish are split open, salted, and spread out on the rocks to dry. After their tails have been tied together, they are hung upon wooden frames until the following June, when they are shipped to Bergen. The heads are dried and pulverized for fertilizer.

Wide World Photograph

REINDEER FORDING THE RY STRÖM, NEAR TROMSÖ

The Ry Ström, a strait and rapid between Kvalöy and the small island of Ryö, is barely 550 yards wide at its narrowest part, and is full of whirlpools when the tide is strong. Tromsö, on the island of that name, has a brisk trade created by the fisheries of northern Norway and the sealing expeditions dispatched annually to Spitsbergen and Nova Zembla. The Lapp settlement near Tromsö keeps a large herd of reindeer, whose thick, rich milk is an important food.

Photograph from Dr. Hugh M. Smith

A BIG CATCH

Whaling is an important industry among the Norwegians, their best hunting ground being the Atlantic Ocean, which recently yielded fishermen 10,000 animals in one year. Whale oil is now hardened by a new process into a creditable butter and margarine, which saved the country from the fat famine that afflicted most of northern Europe during the World War.

Photograph by A. B. Wilse

THREE SPECIMENS OF A LOFOTEN CATCH

The Lofoten fisheries were famous before William the Conqueror landed in England. When the cod, coming in from the depths of the Atlantic, swarm about the banks, they are said to be so dense that they move in serried lines from 100 to 160 feet deep. The islands are mainly bare rocks, with occasional patches of thinly scattered soil, but they are famous for their wild beauty.

called homeliness: there are the family groups on the pier, chatting and laughing; the welcome songs and waving flags of Norwegians greeting compatriots or relatives from the United States, and the pleasant sights in the city streets.

One is not even oppressed by the fjords. They have an air of protection about them, and the schoolboys whom one meets are quite eager to show off their few words of English.

THE COLOR OF NORWAY

When I write the word "Norway" I recall the color of aquamarine, or of snowy icebergs having a translucent, bluish tint, because in a group of symbolists in Paris, at a time when certain French poets believed that every word has its color, one of the most distinguished of them gave these tints to Norway.

Now, the colors of Norway are not the hard hues of the symbolist. They are the red of pleasant fires, the blue of familiar skies, and snow which adds to the enjoyment of life.

It is related of a tourist that he penetrated into one of the lonely farms, or *gaarde,* where the sun is seldom seen. He met there a Norwegian boy of perhaps twelve years of age, who was earnestly studying a tattered Italian grammar. Through his interpreter, the tourist asked why.

"We Norwegians," the boy said, "all choose a land to go to; my grandfather went to Italy and came back here. There was too much sun in Italy; it must be terrible to have the sun all the time."

It was in the early winter, and the tourist asked, "But would you stay away from your own country a long time?"

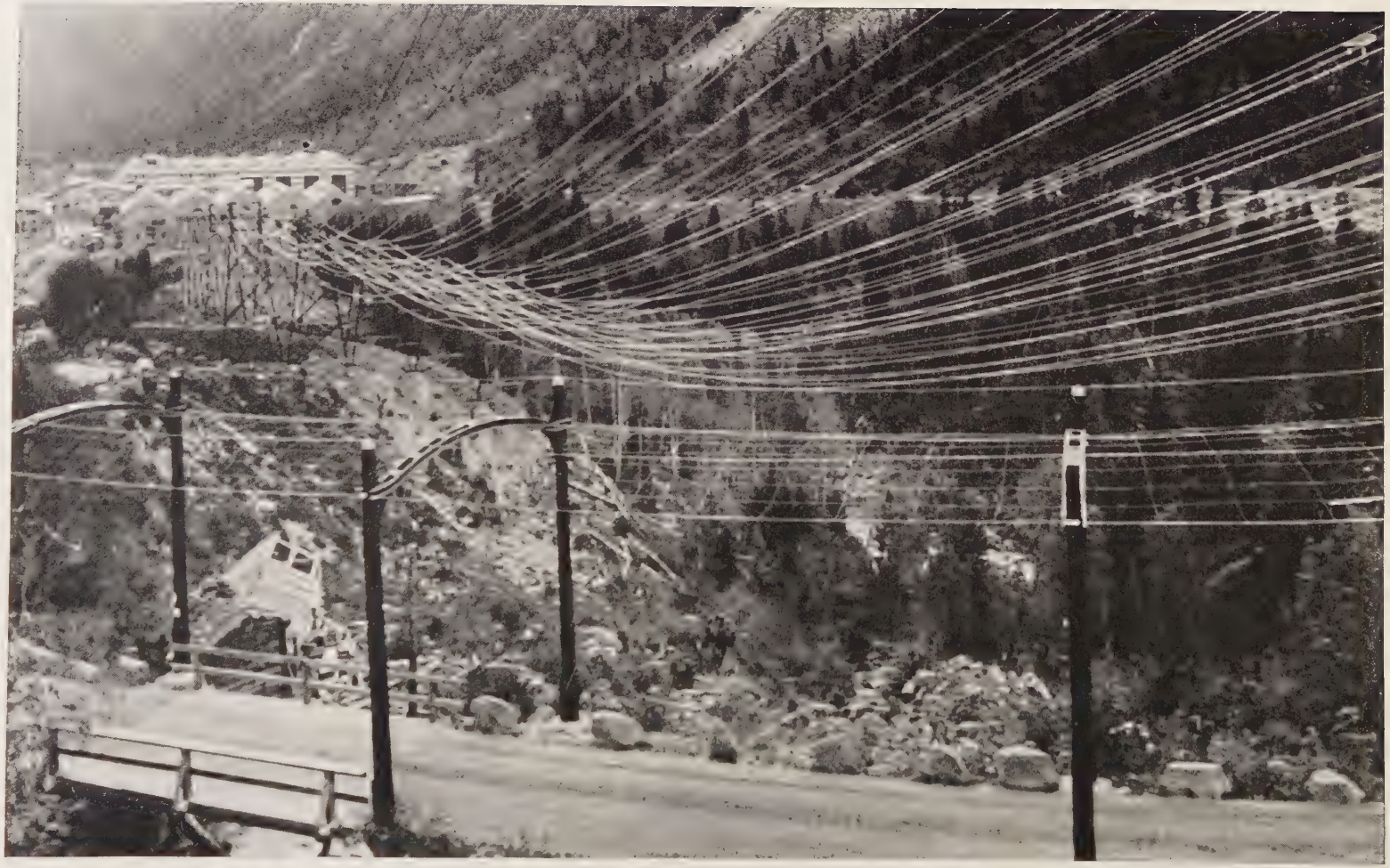
"Oh, no," said the boy, "I should always come back for Christmas, for Christmas here is like heaven!"

The tourist was from Los Angeles.

Photograph from Frederick Simpich

A NORWEGIAN SKIPPER

The rugged, island-fringed coast of Norway is one continuous series of sheltered harbors for thousands of miles, leading up into the Arctic Circle—a factor which has been instrumental in developing a nation of sea-rovers and fishermen. The catches of cod, herring, mackerel, and salmon brought into Bergen put that city among the foremost fish markets of the world.



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THE POWER OF A GREAT WATERFALL CARRIED ON WIRES: THE RJUKAN POWER PLANT IN THE DISTANCE

The waters of the Mjösvand, which once beautified the countryside with a magnificent waterfall, are now conducted through a conduit along the hillside and over the turbines of the Rjukan power plant, utilizing the major portion of the 250,000 horsepower which the cataract once possessed to make nitrates from the nitrogen of the air (see illustration, page 659).

Photograph by L. Bodtker

A MOUNTAIN PIERCED BY A NATURAL TUNNEL

The Torghatten, so called because it resembles a Norwegian market hat floating on the sea, towers above Torgen, the island on which it is located. The *Hatlet*, or natural hole through the mountain, 427 feet above the sea, forms a gigantic telescope, to which tourists climb for a view of the countless islands and rocks in the outlying waters.

Photograph by A. B. Wilse

"CROSSING THE BAR": ON A PASSENGER STEAMER IN ONE OF THE DEEP WESTLAND FJORDS

"Would you not," he asked, "like to bask in the sun on Christmas day?"

The boy seemed righteously indignant. "That would be no Christmas at all," he said.

His father and mother, who seldom saw the sky except through clefts in the mountains, joined him. The father spoke a little English, which he had learned from books. He laughed when the conversation was reported to him.

"My little Eric," he said, "cannot imagine a sunlit Christmas." And he went into his wooden house and brought out a sketch on rough paper, made by Eric, which showed the Nativity with a shepherd approaching the manger on skis.

The condescending attitude of the Swede of former years toward the Norwegian was met by a firm belief on the part of the latter that, while he might not be entirely superior, he was *himself,* and that consequently, the opinion of an outsider did not matter at all.

The Norwegian tells with amusement of the American who said to the Swede: "You have no great cities like Minneapolis or St. Paul and no great waterfalls such as we have in the United States."

The Swede proudly enumerated Stockholm and half a dozen cataracts.

"But you have no Indians!" said the American triumphantly.

"Oh, yes; we have," retorted the Swede,

"but we call them Norwegians."

This old story, which emigrated from America many years ago, is not resented by the Norwegians at all. I have tried it several times myself in the country districts.

Norway never loses an opportunity to present herself to the world in the best light, and the Norwegians in every part of the world insist, without undue pomp or ceremony, upon following the scriptural injunction not to hide their light under a bushel.

Photograph by Donald McLeish

AN OBELISK AT FINSE ERECTED IN HONOR OF CAPTAIN ROBERT F. SCOTT

At an altitude of 4,010 feet, amid Arctic surroundings, stands this monument to the English Antarctic explorer. It is inscribed with the names of Captain Scott, Dr. Wilson, Captain Oates, Lieutenant Burrows, and P. O. Evans, all of whom perished on the return journey from the South Pole in 1912. It was in the Norwegian mountains near Finse that Captain Scott and his companions practiced with motor sledges prior to the trip.

SARCASM DOES NOT TOUCH THE NORWEGIAN

Sarcasm does not easily touch the Norwegian, who is, as a rule, very sure of himself. This self-assurance is sometimes a temptation.

There was one mighty hunter and a great singer of fragments from old Norse songs who was never tired of chanting the virtues of the Norwegians. He was, strange as it may seem, a devout prohibitionist and of the most Calvinistic denomination of Lutherans. He believed that all drinkers were bound for perdition. He accepted the ancient heroes of the sagas, who reveled in mead, because they were staunch pagans and knew no letters.

"How is it," I said, "that the Danes in Copenhagen say that nearly every drunken man seen in their streets is a Norwegian, who comes over to that city in order to fill himself with *braendevin?*"

"It may be true," said the old hunter calmly, "because a Norwegian would be ashamed to be seen drunk among his own people."

Whether he really believed it or not, he met every insinuation as to the existence of any defects in his own people by turning these defects into virtues.

TWO UNHAPPY EXILES

The Norwegian may be found anywhere. The boy among the mountains,

Photograph by A. B. Wilse

ONE OF THE MOST BEAUTIFUL OF NORWEGIAN WATERFALLS, THE LAATEFOS

The Laatefos and the Skarsfos tumble over the hillside from Sandven Lake and mingle their waters in their descent. The black rocks behind them accentuate the whiteness of their foam and spray.

THE FLOWER MARKET OF CHRISTIANIA

Flowers are for sale in Norway every summer day, but in nearly every large city of the country one day of the week is the flower day of the markets, and about the open square portable greenhouses tempt the buyer with fresh blooms of every shade and fragrance.

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ANCIENT OIL LAMPS OF NORWAY IN THE HANSEATIC MUSEUM OF BERGEN

The trays were filled with fish oil, and wicks in the corners of each tray furnished the light. A three-tray lamp became a candelabra of twelve lights. The Museum contains a valuable collection of furniture, weapons, and other objects of the latest Hanseatic period.

with his Italian grammar, was simply following the urge of his race.

It is true that the pine tree longs for the land of the palm, and the palm tree for the land of the pine. Heine has forever crystallized this truth in one of the loveliest of his lyrics; but I think two of the unhappiest beings I ever met were in Louisiana, in the month of May—late in May. They had earned their living by picking cotton during the previous summer, and they described their experience as Dante describes some parts of the infernal regions.

The worst was over, but in order to get money enough to leave this "burning place," as they described it, they had made a contract with a builder until June. Even in May they reminded one of those unhappy dogs whose tongues hang out in the heat. Their one hope seemed to be to see the falling snow again. They hated the perpetual sunshine.

Their other objection to Louisiana and

Photograph by Donald McLeish

DOMESTIC UTENSILS, DRINKING BOWLS, AND A CHAIR OF VIKING DAYS

The old sea lovers of Norway fashioned their double-handled drinking vessels like boats. The Bergen Museum contains an excellent collection of these Norse antiquities. The chair was cut in one piece out of the trunk of a tree and is of a type still in use in the country districts.

a plantation was that there was not enough to eat, although if there is one State which seems to provide most bountifully for its inhabitants it is Louisiana.

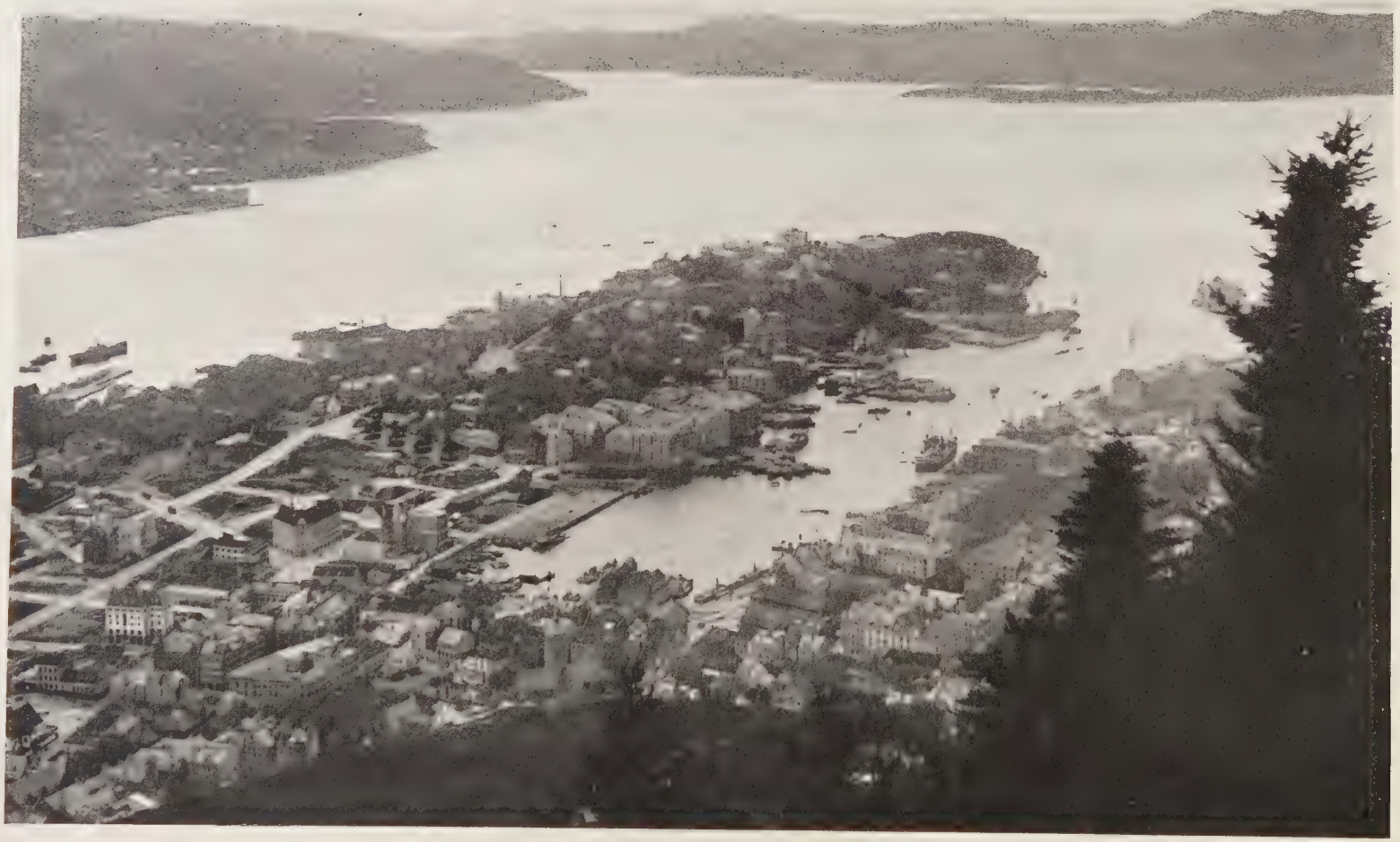
They abhorred the dishes of the land; okra filled them with an unutterable disgust and the cheese offered them was looked on as an evil substitute for the beloved goat's cheese of their country.

"In Norway," they explained, "even on a poor farm, we have six meals a day." And they did not exaggerate.

The worker on the gaard expects coffee with *smörbröd* at 5 o'clock; at 7:30 salt meat is welcome; at about 11 o'clock his principal meal is ready; he takes his coffee at 1 p. m.; at 4 the delicious *gjetost,* sometimes called *"mysost,"* the goat's cheese, dreams of which reconciled these two lonely Norwegians to life.

A REBUFF FOR THE KAISER

The German Emperor spent more than twenty-five seasons in Norway; but,



Photograph by Donald McLeish

BERGEN FROM THE FLOREN HILL

The voice of the past continuously speaks to the visitor in Bergen, where one finds the Viking, the Hansas, and the modern mercantile marine represented in the port. Women in Paris creations rub elbows with peasants in their native costumes, and crude country carts move through the streets by the side of modern taxis. The city also enjoys the unenviable reputation of being the wettest in Europe, its rainfall averaging about 72 inches annually. In the background are the mountainous islands which shelter the harbor from the North Sea.

Photograph by A. B. Wilse

A PLEASANT SUMMER PASTIME—BOATING AMID THE THOUSANDS OF ISLANDS THAT FRINGE THE COAST OF NORWAY

outside of his special court, he received no particular marks of reverence from the honest Norwegians. In fact, he had learned not to expect them.

There is a story told of two Norwegians who crossed the path of the Emperor, going from one farm to another, munching bread and herring as they went. The Emperor was alone, his equerry being some distance behind him, engaged with two horses. These peasants were elderly men, white-bearded.

The Kaiser was in the act of examining a shrub and he dropped his glove. As the old men approached, he straightened himself up and glanced meaningly at the fallen glove.

"Pick it up yourself," said the elder of the farmers. "You are younger than I am," and they passed on without the slightest self-consciousness, much to the horror of the equerry, who afterward told the story with bated breath.

A THRILLING WINTER SPORT—STEERING A "KJELKE"

The traveler in Norway ought by all means, if he can not conquer the ski, learn to steer a *kjelke*. It is a small sled which holds two persons. It is steered by a pole, which may be held under the arm and makes a tail for the kjelke.

The skill of the Norwegian girls in steering these sleds approaches the miraculous. They seem to have the instinct of the mountain goats.

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THE CARL-JOHANS-GADE OF CHRISTIANIA LEADING TO THE KING'S PALACE

Along this main thoroughfare of the capital, extending from the chief railway station to the palace, are the Stor-Torv, or great market; the Church of Our Savior, constructed in 1697, and the Norwegian parliament houses, from which this photograph was taken.

Photograph by A. B. Wilse

A DAUGHTER OF THE SNOWS

Norwegian women are irrepressibly energetic and splendidly fearless. Many of them excel in skiing, sailing, mountain climbing, and various other out-of-door sports. Their industry and independence of spirit lead them into nearly every field of professional and commercial endeavor.

Photograph by P. O. Bugge

COLOSSAL BRONZE STATUE OF FRITHJOF, LEGENDARY VIKING WAR-LORD, AT BALHOLM

A very polite young American, versed in sports, happened to meet a young girl about to join a procession of torchbearers one snowy evening in Christiania. She seemed rather slight and fragile, in the twilight, and very respectfully he asked, "May I assist you?"

It seemed to him a foolhardy thing that a young girl should start out in falling darkness in such a doubtful vehicle as the kjelke, which he had never seen before.

He evidently did not see what the novelist would call her "enigmatic smile."

"Oh, yes," she said in English. "Yes; get in."

He took the other seat with the feeling and the air of protector. He had played football at Harvard. The kjelke started. It joined with tremendous swiftness the procession of sleds. Skirting precipices, within an inch of gulfs, up and down; almost with the speed of a locomotive, the kjelke flew. He held on with all his might. It seemed to him as if his fur cap would be at any moment torn from his head. He confessed that even in the trenches he had never felt the doubt and fear that oppressed him.

After what seemed to be many hours of horror, the kjelke stopped at the end of a Christiania street, surrounded by torch-bearing and singing students. The young lady gave him her hand and said sweetly, in his native tongue, "May I assist you?"

He never saw her again, and he confessed very ungallantly that he never wanted to see her again. No sport known in England or in America prepares one adequately for this winter sport in which the Norwegians have acquired unexampled skill.